STUDIES IN PROFITABILITY OF A SMALL RUBBER COMPONENT MANUFACTURER.

by

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SUMMARY

The research described in this thesis covers the attempts made to improve the profitability of a manufacturing unit operating at a substantial loss, and analyses the reasons for success and failure of the various elements of the project.

A department producing small precision rubber mouldings for the automotive industry, was the subject of the work. This unit, at the start of the project, was operating with total costs exceeding sales revenue by 50%; and the project brief was to investigate ways of rectifying this unacceptable financial position. Following a period of introduction and familiarisation, a preliminary analysis of the problem area was made and areas for action identified. It was decided to concentrate on reducing variable costs, and to this end a large number of cost saving ideas were generated.

These cost saving ideas had to be evaluated on a financial basis. This was to ensure that research effort was not wasted on non-profitable ideas. The evaluation was performed in a logical and disciplined manner, a process that is by no means commonplace in industry. For each idea all arguments for and against were listed, and then where possible, financial values assigned to each argument. In this way an accurate evaluation of savings resulting from indivudal ideas was produced. On the face of it the process of evaluation is relatively straight forward, but in this case much of the information was not readily available, and the process of data collection involved the production of simple variable cost models of the department, analysis of accounts and inspection records, and in some cases talking to people and obtaining estimates from them.

With the agreement of factory management, a programme of evaluated cost reduction ideas was prepared. This programme, containing some 25 projects, was implemented by factory staff and the author with a large degree of success, making a considerable impact on the department's loss. Indeed the research was continued to evaluate effects of the programme, and to place its contribution into perspective by examining the effects of other actions that had brought the department to a break even point.

Then an attempt was made to repeat the work, by instructing staff in the method of evaluation and implementation of cost saving ideas.

Finally, the author proceeds to assess the overall achievement, reviewing the approach adopted in the light of relevant management literature, and prescribing guidelines for use by other researchers attempting similar work.

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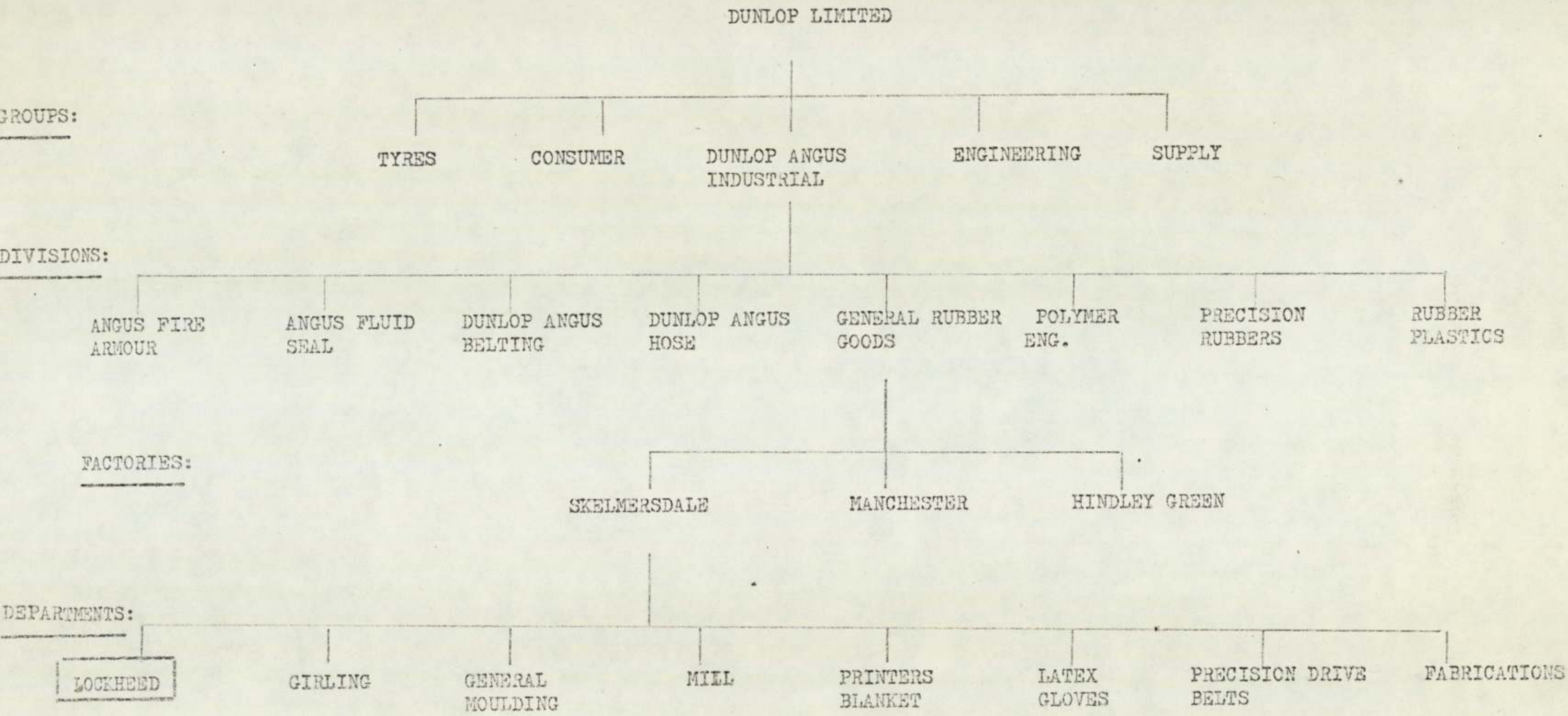
CHAPTER 1 - INTRODUCTION

The project described in this thesis sets out to discover and evaluate a portfolio of possible lines of action for the improvement of profit in a manufacturing unit operating at a substantial loss; to devise means of selecting which lines should be pursued; to pursue the lines chosen and to implement the results. Following this the research proceeds to assess the overall achievement; to review the approach adopted and its effectiveness, in the light of relevant Management literature; and to prescribe the procedures for use by others in different circumstances.

The Dunlop Company, in whose General Rubber Goods Division the project is based, had its origins in the invention of the first pneumatic tyre by John Boyd Dunlop in 1888. The Pneumatic Tyre and Booth Cycle Agency was formed a year later to market Dunlop's invention. By 1900, when the name of the Company was changed to the Dunlop Rubber Company Limited, manufacturing or selling operations had been established in Australia, Canada, France, Germany and South Africa. Since then the Company has expanded and diversified into other markets, with a world wide sales revenue in excess of £500,000,000 p.a., and a total work force of over 100,000. However, tyres still remain the most important individual product, accounting for some 60% of the total Company turnover.

The Company is divided into five main product groups, Tyres, Consumer, Dunlop-Angus Industrial, Engineering and Supply. These groups are broken down into dividions, the General Rubber Goods Division being part of the Dunlop-Angus Industrial Group.



THE LOCKHEED DEPARTMENT IN RELATION TO THE COMPANY STRUCTURE.

FIG. 1 .

As the name implies, the General Rubber Goods Division produces a wide range of rubber products, including a variety of products for the automotive industry, rubber blankets for the printing trade, small rubber boats, and rubber backed carpet. The division is contained in three factories in Lancashire, at Manchester, Hindley Green and Skelmersdale. It was in the Skelmersdale factory that the project was located.

The factory is representative of the diversity of the General Rubber Goods Division; containing separate departments manufacturing latex hourseheold gloves, large fenders for super-tankers; printers blankets, precision drive belts and general rubber mouldings for the automotive industry. There are two departments at Skelmersdale producing small rubber components; the Lockheed and Girling Departments, named after the companies they supply. The subject of this thesis is centred on the Lockheed Department.

The Skelmersdale factory is built on a modern industrial site served by the Skelmersdale New Town Development Scheme, and in 1971 when the project started, the factory had been operating for three years. The siting of the factory was influenced by the financial inducements offered by the government of the day, to encourage industry into the area. The idea was that the new town development would provide accommodation and facilities to support the work force for a large industrial site. The town was also intended to serve as a resettlement area for residents from Liverpool affected by slum clearance and development work. Thus, the work force of 1,200 consisted mainly of 'exiled Liverpudlians' and a few ex-textile workers thrown up by the contraction in the Lancashire textile trade.

Some of the 8 production departments in the factory were completely new, making new products on new machinery, the remainder were departments from other company divisions relocated at Skelmersdale. The Lockheed Department had been moved from Grimsby, where it was previously part of the Dunlop-Angus Hose Group.

Only two of the eight departments were profitable with the factory overall operating at a considerable loss. Hence its future as an operating unit was constantly under review, and labour relations were consequently uneasy.

The Lockheed Department, losing some £300,000 p.a. on a sales turnover of £600,000 was a major drain on overall profit. The future of the factory was therefore partly dependent on a radical improvement in the operating situation of this department. It was also important that, regardless of the position of the factory, the department should be established on a firm financial basis.

The 'brake-seal' business of the division is divided between the Lockheed and Girling Department. These are both situated in the Skelmersdale area, but the Girling Department operates as a single unit some distance from the main Skelmersdale factory. The departments supply the two United Kingdom brake systems manufacturers; Automotive Products Limited and Girling Limited. These two companies have an almost equal share of the U.K. market, both companies supplying the major U.K. car manufacturers. Situations like this with two or more companies supplying the same manufacturers are common in the motor industry, to reduce its vulnerability to suppliers' strikes. Indeed it is likely that the systems supplied by different suppliers and even parts within the systems, are to a certain extent interchangeable.

Automotive Products (A.P) Limited, depend on three suppliers for the rubber components used in their braking systems, namely: Dunlop (Lockheed Department), Alfred Roberts Limited and Dowty Limited. The Lockheed Department is A.P's major source of supply, taking nearly 60% of the Automotive Product's market, which in turn represents nearly 30% of the total U.K. brake seal business.

The two other suppliers were Alfred Roberts, now a wholly owned subsidiary of A.P. and Dowty. If we look at figs. 1 and 2 we see that the 1970/1972 period was important since at this time A.P. altered the emphasis of their suppliers.

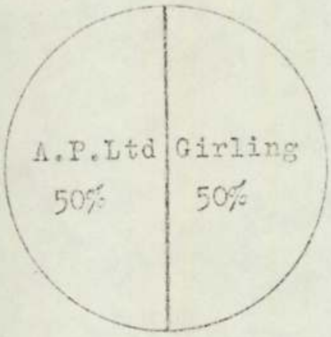


fig.1.1. U.K.BRAKE SEAL MARKET

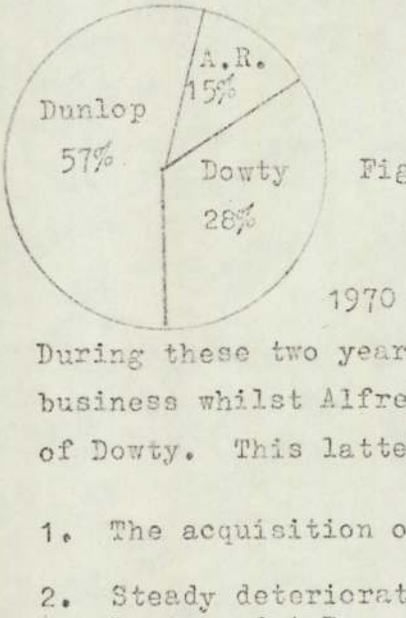
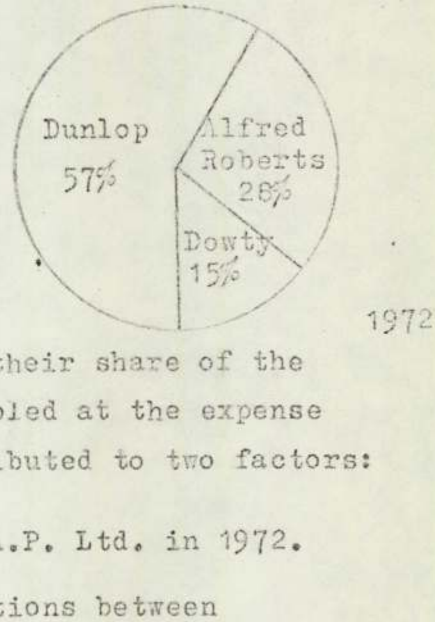


Fig.1.2. A.P's SUPPLIERS.



During these two years Dunlop maintained their share of the business whilst Alfred Robert's share doubled at the expense of Dowty. This latter change can be attributed to two factors:

1. The acquisition of Alfred Roberts by A.P. Ltd. in 1972.
2. Steady deterioration of customer relations between Dowty and A.P.

It can be appreciated that when the I.H.D. project began in late 1971, the situation was rather fluid, and this, to a certain extent influenced the direction of the project.

To be more specific, in late 1971 Dunlop's relations with Automotive Products were not good. The department had arrears equivalent to approx. one month's deliveries. This meant that the customer was virtually dictating to the Lockheed Department, which parts should be made when, by calling for an immediate delivery of those parts on the arrears list. This in turn meant that the department was run on a day to day basis, in an attempt to overcome this short term crisis. Invariably in this type of situation, customer relations are poor, and they often influence the customer's sourcing policy. Thus, if the department was to maintain its share of the market, customer supplies had to improve. Also the higher factory Management were aware of the fluctuations in the positions of A.P's other suppliers. Hence there appeared to be two very important points:

1. Because of poor customer relations due to inferior quality and inadequate supplies, it was likely that Dowty Limited would be phased out as a supplier by the end of the decade.

2. Although A.P. had acquired Alfred Roberts, the capacity of the Company was limited, and unlikely to replace Dowty completely.

Therefore, an opportunity existed for expansion provided increased business did not mean increased financial loss.

The alternative to expansion of the department was closure, which may have seemed especially attractive since much of the machinery was so old that it had long since been written off the assets.

However, from a Company viewpoint, the implications of closure were such that the action was considered unacceptable.

As already mentioned, the Lockheed Department accounted for some 30% of the total U.K. 'brake seal' business. Had they withdrawn completely, Automotive Products would have been unable to replace them as their major supplier, or to expect increased output from their other sources. This would have lead to disruption in the motor industry as stocks for braking systems ran down. Obviously, a Company such as Dunlop, obtaining two thirds of its total Sales Revenue from the motor industry, could not afford such disruption and the effect it might have on sales. Furthermore, the reputation of the Company as a whole was likely to suffer when it became known that one of their Divisions was responsible for the disruption. Thus, it was imperative that a major part of the business should not be jeopardised by a small department, whose turnover represented less than ½% of the Company's U.K. sales.

In general terms, the problems that faced the Company when I.H.D. work began in 1971 were as follows :-

1. They were operating a small department at a large loss - £300,000 p.a., which they felt they could not close down for reasons indicated.
2. The loss was a major reason for the Skelmersdale factory's financial state, which held the possible threat of factory closure over the work force.
3. Because of the changing state of the A.P. market, an opportunity for expansion was available, if customer relations could be improved, and the operation made financially viable.

The Company were looking for short term actions, designed to make the department profitable.

CHAPTER 2

The Preliminary Investigation of the Problem

The initiation of the project, various training experiences, and the approach to generation of potentially profitable ideas for the department are discussed in turn.

2.1. The Initiation of the IHD Research Project

As indicated in the introductory chapter the department was highly unprofitable, and a considerable problem to the Company. The factory management felt that the situation was almost a fight for survival on two fronts :

1. The department had to improve customer relations and demonstrate that it was capable of achieving a satisfactory delivery situation.

2. For the continuation of the Skelmersdale factory unit, the department had to take rapid action to extricate itself from an unacceptable loss situation, or at least show that it was capable of significant improvement.

When the Factory Manager decided to sponsor a three year research project at the factory, he was concerned that it should facilitate this 'fight for survival', and when the administrative arrangements for the project were made, it was agreed that whatever form the project took, its general aim should be to reduce the departmental loss. A specific project was not defined at this stage, in order that the selection of a project could form part of the research programme. The initial approach to this programme is the subject of this chapter. Personal relationships established at an early stage were a key factor in later successful implementation and many contacts and meetings are described. Hence the text is a combination analysis and narrative. Subsequent chapters provide a more detailed account of what was discovered about the way the department operated, and an analysis of potential projects.

The main choice lay between :-

(i) management selecting a project from their experience,
(ii) having several alternative projects evaluated, and
(iii) having projects both generated and evaluated.

Usual practise with IHD projects is to select one to which the disciplinary areas of the two academic supervisors can contribute and Production Control was one such topic which was mentioned. The disadvantage of such an approach was that the best project from the Company's standpoint might be missed. This danger could be avoided by leaving project selection to factory management, which was still rather restrictive and contrary to the request of Mr. Air (Factory Manager) for an outsider's view. The third option for the Student was to collect and generate ideas for various projects, and by appraisal/evaluation make a selection from this list. Such an approach was likely to produce ideas about which 'management' would have strong opinions, and it would be important to avoid polarisation of views. The manner in which this was approached is discussed later.

Ultimately, after considerable discussion, it was agreed that there should be a period of introduction, both industrially and academically, to facilitate the collection of ideas for profit improvement. The only remaining problem was whether the ideas should be collected during or after the induction period. Time could be saved if collection was performed simultaneously and also the emphasis of learning would change from purely "sitting and watching" to "questioning".

Thus full time research began in September with an induction period. The industrial and academic components are now described, followed by some comments on the process of the generation of ideas during this period.

2.2. Industrial Induction

The industrial initiation took the form of brief periods of practical experience in as many aspects of the department as possible. This period lasted approximately three months, and the time was spent as follows :-

1. General introduction - 1 week
2. Assistant to Moulding Foreman - 8 weeks
3. With Finishing Foreman - 1 week
4. In Technical and Inspection Sections - 1 week.
5. In Production Control and Accounts - 1 week.

2.2.1.

The first week was a general introduction to departmental and services managers, and other important personnel. This initial period of contact with factory personnel was helpful in the sense of providing a quick overview of all the factory functions and senior personnel , It also made a vital contribution to the long term co-operation from the most important members of staff connected with the project, as they were aware from the outset "who I was," and "what I was doing".

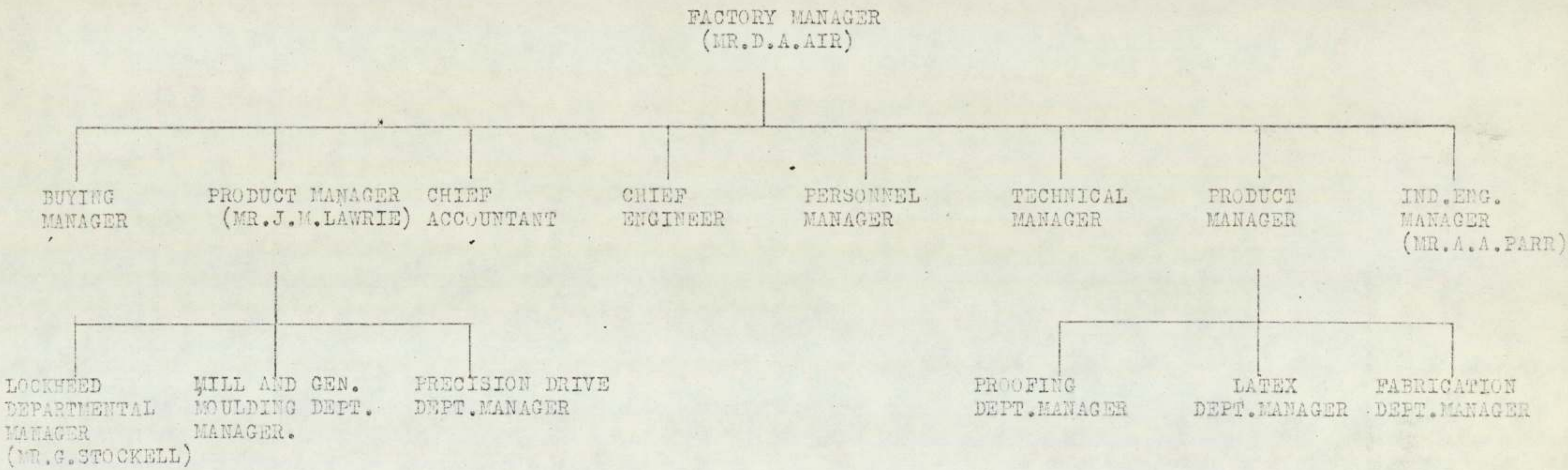
Fig. 2.1. shows the positions and names of the managers who appear during the subsequent account.

In general, the reaction of management to the knowledge that the project was to be conducted in the Lockheed Department brought expressions of sympathy, such as "the best of luck, you'll need it!"; although this wasn't the view of the departmental manager, Mr.G. Stockell, who had recently joined the department from the Tyre Group, and like myself, was still feeling his way.

2.2.2.

This first week was followed by two months as assistant to one of the six moulding foremen. This was intended to provide an insight into the production process, and first hand experience of the problems facing shop floor supervision.

The basic function of the foreman in the department was to organise and control his work area in order to produce what was required on time, and at the lowest acceptable cost. This entailed the manipulation of labour and machinery within the constraints present, to meet departmental objectives. He had to know the limitations of the equipment, the weekly objectives in terms of output, and the capabilities of his work force. It was also important that he was able to recognise when and why his output was falling below the required quality standards, and be



SKELMERSDALE (MAIN FACTORY) - SENIOR AND MIDDLE MANAGEMENT STRUCTURE

(SEPTEMBER 1971)

FIGURE 2.1.

able to take corrective action. Finally he was expected to maintain stable industrial relations.

Considerable knowledge was gained during this period, and the description of the production process in the following chapter is based largely on the information gained whilst working with the foreman.

2.2.3.

The next week was spent in the Finishing Section where excess rubber was removed from the moulded parts by various methods. The responsibilities of the foreman were similar to those of the moulding foreman.

2.2.4.

Then a week was spent in the Technical Department, an important service department, because :

a) They set quality standards for a high quality product.

b) The control of the inspection section, which determined the 'good' output of the department, was administered by the Technical Department.

2.2.5.

The final week of the induction period was spent briefly looking at the Production Control Department and the accounts systems.

Throughout this period of industrial induction, I had a weekly meeting with the departmental managerm Gordon Stockell. During these meeting many aspects of the department were discussed, including the various comments of different personnel about particular problems. These discussions helped to ensure that I obtained a 'balanced' understanding of the department and the people in it, and were therefore of considerable importance.

2.3. Academic Induction

This period of industrial introduction was combined with an "academic" introduction to the concept of an IHD project, and also various academic techniques which would be available to me. The academic work undertaken in this initial period included :-

1. A five-day intensive course in "Process and Process Plant Economics".

2. A lecture course in management accounting.

3. Seminars on various IHD topics and themes.

The direct value of these courses is difficult to assess, if we only consider the direct application of the knowledge gained. However, they did make indirect contributions of some importance, which are outlined below.

The first course attended was a five-day intensive course designed for the chemical engineering industries. It was used as a general introduction to industrial economics, and academic industrial terminology and theory. The course helped outline the fields of academic influence in industry and indicated areas of academic activity. Furthermore, the financial accounting content of the course helped to provide an initial understanding of the departmental accounting systems, prior to attendance at the University accountancy course.

The course on management accounting provided information of more direct value to the work in its early stages. Understanding departmental accounts in the initial stage, and analysis of departmental accounting ratios later, were certainly simplified by knowledge obtained on the course.

Attendance atIHD seminars during this early stage of the work was very important. Coming straight from an academic background, adjustment to, and acceptance of the IHD concept was not easy. Acceptance was greatly helped by attendance at seminars, when one could meet and talk with not only course tutors, but also more experience students.

Perhaps the most important sector of the academic introduction was a weekly meeting with my main supervisor. It was during these meetings that the progress and direction of the research was discussed and planned. Again this was an important part in the process of coming to terms with the somewhat unfamiliar IHD concept. Also it was during these meetings that targets were set for the completion of various stages of work. This was important in maintaining initial momentum during a period in which the work was of a general nature, and being conducted by a researcher who was a little unsure of the direction of his projects.

This is of course, a general problem to all research students, but possibly more so to an IHD student who has to ascertain the objective of :-

1. The sponsoring Company.
2. Industrial Supervisor.
3. Main academic Supervisor.
4. Associate acamenic Supervisor.
5. Himself.

All the objectives may differ slightly and the researcher must reconcile differences and obtain agreement, whilst steering the course of work.

2.4. Hypothesis Generation

The initial survey of the problem area was to help generate ideas for cost reduction actions, which in turn would provide the basis for a specific area or areas of work. The "hypothesis generation" was approached from three angles :

1. A 'personal brainstorming' approach, beginning with the author's view of the department and trying to question existing methods, and/or think of ways to do things better, or attempting to solve some of the apparent problems. A challenging attitude was adopted, as in Work Study, asking questions such as :
What is the purpose of this task/process? (Need it be done at all?)
Why is it done here? (Could it be done elsewhere?).
Why is it done by X? (Could it be done by Y?)
Why is it done this way? (Could it be done some other way?)
(Could it be combined with something else?)
Why is it done at this time/stage?
etc.
This was very much an "ongoing" process during the introductory period, with some ideas arising from questions to various personnel about their specific function in the department.

However, the idyllic picture of a keen research student, deep in thought, producing outstanding innovatory ideas, is far removed from the actuality of a sleepy student trying to think of ideas at four in the morning, seated at the moulding foreman's desk with a mug of cold tea in one hand, and a greasy sausage roll in the other ! Having experienced the working conditions and prevailing pressures within the department, I began to understand why the process of change in industry tends to be slow.

One consequence of generating ideas in this way is that people become indentified with their own ideas, take criticism of them personally, and over-argue their strong points. Conversely, they are quick to see the snags with other people's ideas and become "polarised" in opposition.
Consequently the next two sources might be expected to be more fruitful in terms of implemented results, if not in "white hot" Ph.D. style creativity.

2. The second source of ideas was the people associated with the department, and the problems they described to me. Here, I could either directly accept the problem or a modification of it. However, care was required, since there was always more than one way of viewing a production problem. Indeed, a moulding foreman's view of a particular problem and its causes, was likely to be totally different from those of members of the Technical Department. This served to highlight the importance of the whole of this induction period, both the first week and later, spending time not only on the "shop Floor", but also in the service departments.

3. Finally, the third source of ideas was the suggestions scheme. This proved very unsatisfactory as no records had been kept, and presumably any promising ideas had already been implemented.

Later in this thesis, (Chap.13) some comments are made on the process of creativity and hypothesis generation, and the author's approac compared with present methods, and theories for production of ideas.

2.5. Alternative lines of approach

It is perhaps useful to consider the alternative lines of approach, briefly outlined in 2.1, that might have been adopted during this initial phase of investigation of the problem area, and search for possible ideas for research.

e.g. 1. The factory manager, Mr.D.Air, or the departmental management might have selected what they believed to have been an important area for research. However, Mr.Air felt that perhaps the present management has been living with the problem for too long, and therefore "couldn't see the wood for the trees". He also felt very strongly that the initial investigation should be conducted from the standpoint of an unbiased independent agent, viewing the problem from the outside for the first time.

If this initial approach was a total failure, then Management might from experience suggest possible lines of approach.

e.g. 2. Rather than spend three months on the "shop floor" and in service departments, the investigation might have taken the form of a detailed examination of all the data available about the department. Again, Mr.Air had strong feelings, and he considered that it was vital for the author to understand "what and who" made the department tick," and certainly if I was to involve members of the department in my work, then it was important that a working relationship be established as early as possible. Indeed, the induction period helped to indicate just what data was available, and how it was generated and furthermore, a certain amount of analysis was performed during this period.

e.g.3. A third alternative might have been a historical view of the departmental accounts to determine how long the loss situation had existed, and how the department had been run in any period for which it had been profitable.
Unfortunately, the accounting records were not available for the period prior to the move of the department to Skelmersdale. Also this would not have necessarily indicated why the department was in its present state.

All these approaches are more restricted than the approach adopted, the elements of which might be described as follows :-

1. Production of an initial statement of the perceived problem.
2. Understanding the components of the problem.
3. Understanding the management objectives and developing client relationships.

4. An examination of the problem area and the possible "tools" available to aid solution.
5. Brief analysis of the accounts.
6. Hypothesis generation for possible solutions, through learning the "language" of the process and challenging the technology.

This approach attempts to take an objective standpoint, whilst laying the foundations of personal relationships, which become important when implementation of solutions is attempted. Also it aids the transition for the researcher into an industrial environment from an academic background.

Thus the induction period concluded with two end products, a knowledge of the workings of the department and a list of potential cost reduction ideas. What these ideas were, and how they were treated, is described in Chap.4. Before this, Chap. 3. gives some of the detail discovered about the department during the initial period.

Chapter 3. The Lockheed Department

This chapter describes the product, the production process, and the financial situation of the department as discovered during the initial period of induction.

There are two reasons for doing this :

1. Such a description was not readily available when the author joined the Company, and the initial introductory period was spent gathering this information. The presentation of information in the form of a process flow chart was new to the members of departmental staff, as was its later use as a basis for departmental cost models.

2. Many of the ideas for profit improvement were directly related to particular stages in the production process, a description of which may, therefore, give the reader some idea of the practical implications of change.

3.1. The Product

The department produces small rubber components for the automotive industry. These components can be split into two basic types :

(i) seals i.e. hydraulic systems components, and (ii) boots and dustcovers. i.e. parts that provide protection from dirt and dust. Examples of both types of components are shown in fig. 3.1 (Photo). Seals, which account for 70% of the output of the department, are used by the customer in the hydraulic systems operating the brakes and clutches in motor vehicles. It is therefore imperative that only perfect parts are used in the systems, since failure could have very serious consequences, not only for the occupants of the vehicle, but also for the Company in terms of civil or criminal liability.

3.2. The Process

Both types of components are first moulded into shape, and then reduced to customer specified dimensions by one or more 'finishing' operations.

Fig. 3.2. is a simple diagrammatic representation of the production process, showing the various stages of production.

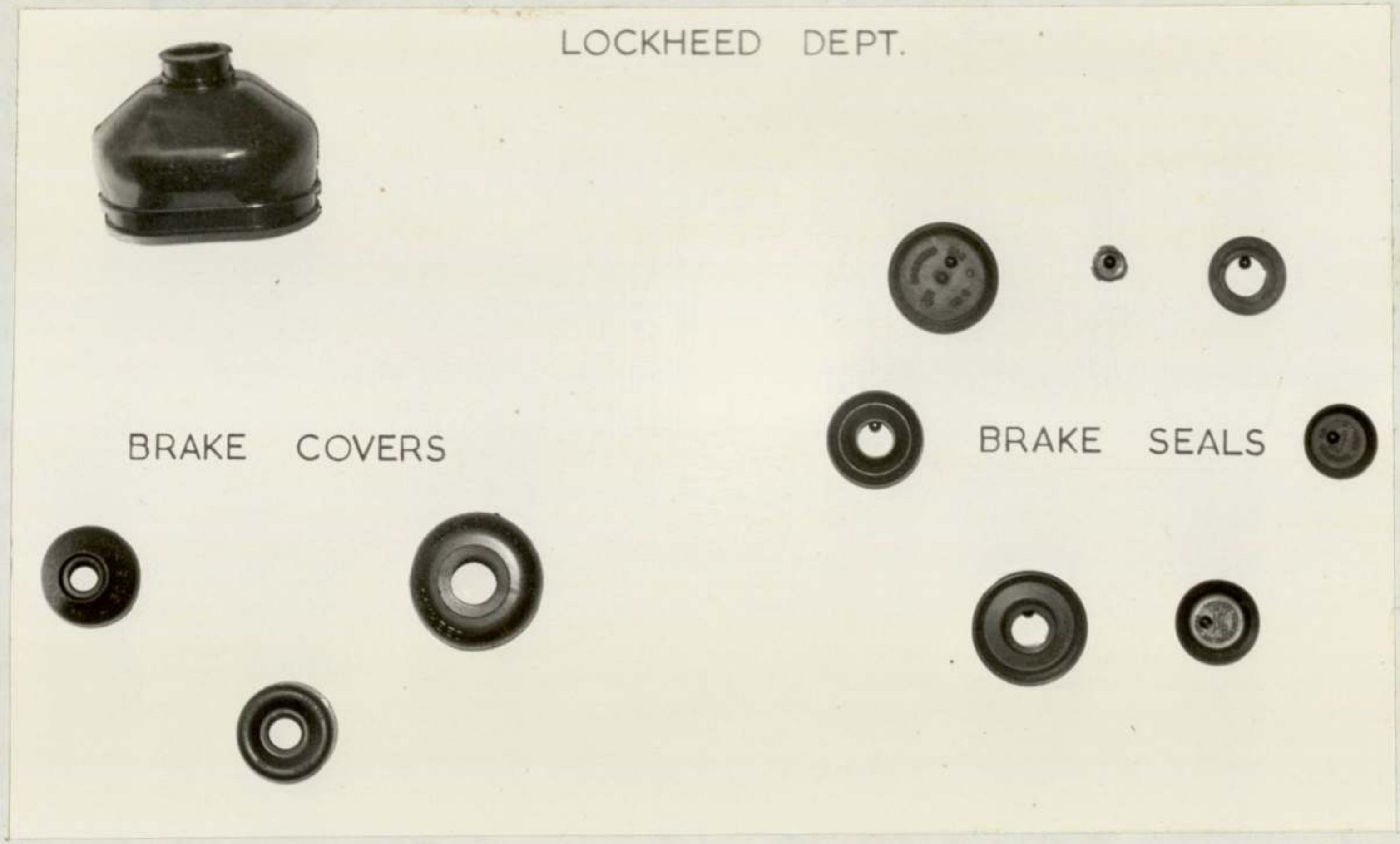


FIG.3.1

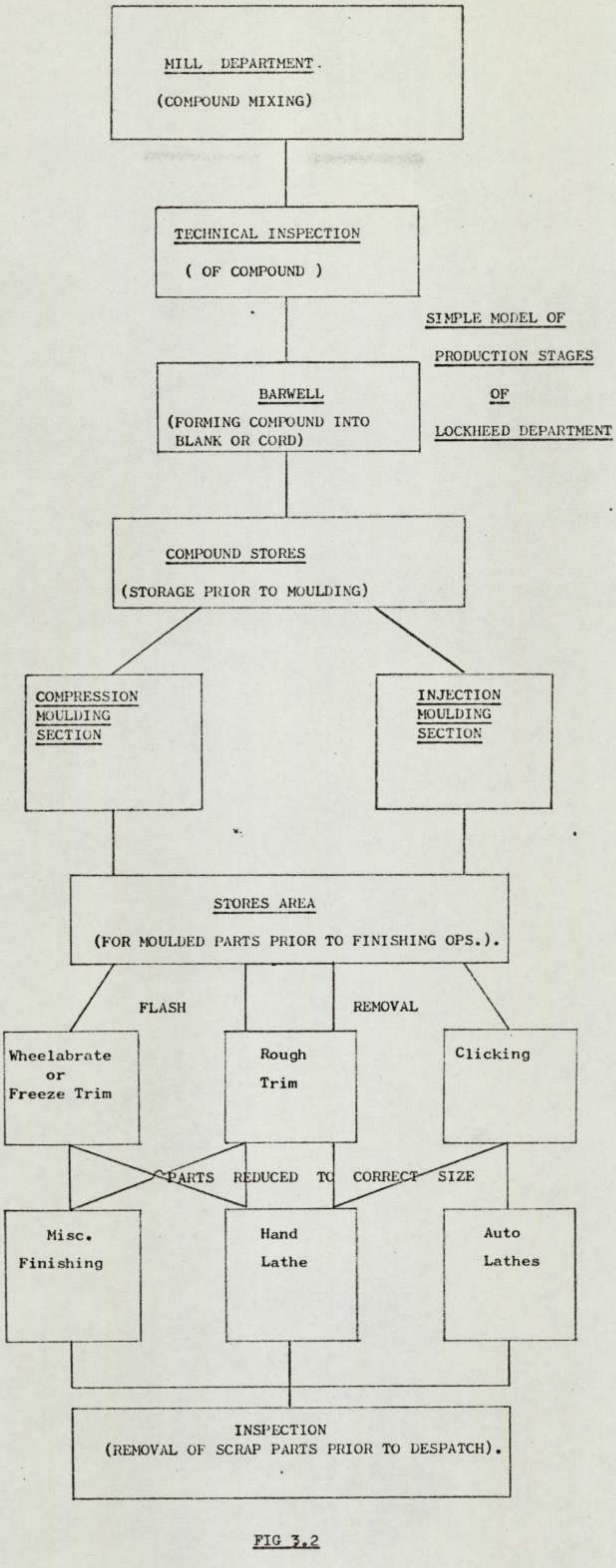

MILL DEPARTMENT.
(COMPOUND MIXING)
TECHNICAL INSPECTION
(OF COMPOUND)
SIMPLE MODEL OF
PRODUCTION STAGES
OF
LOCKHEED DEPARTMENT
BARWELL
(FORMING COMPOUND INTO
BLANK OR CORD)
COMPOUND STORES
(STORAGE PRIOR TO MOULDING)
COMPRESSION
MOULDING
SECTION
INJECTION
MOULDING
SECTION
STORES AREA
(FOR MOULDED PARTS PRIOR TO FINISHING OPS.).
FLASH
REMOVAL
Wheelabrate
or
Freeze Trim
Rough
Trim
Clicking
PARTS REDUCED TO CORRECT SIZE
Misc.
Finishing
Hand
Lathe
Auto
Lathes
INSPECTION
(REMOVAL OF SCRAP PARTS PRIOR TO DESPATCH).

FIG 3.2

(This simple model of the department was a direct result of the induction period and the author's understanding of the process and the department).

Each component is made in a specified material, having the properties which meet the specifications required by the customer. In a department regularly moulding in excess of 250 different parts, great care is needed to ensure that the correct compound is used for each type of part. The case is somewhat simplified since similar types of parts are made from the same compound. When the project began, the department was regularly using 19 different types of compound, although attempts were underway to reduce this number.

All compounds are mixed on site by the Mill Department, in the quantities requested by the department. Then, after the compound has been tested by the Technical Department, it is purchased from the Mill Department.

The first operation performed on the compound within the Lockheed Department is to form it into a shape acceptable to the moulding machinery. This is done by reheating a quantity of the material on a mill, and then passing it through a type of extruding machine. This machine, known as a 'Barwell', forms the material into a long cylindrical strip approx. 2" in diameter, known as 'cord' (because of its rope like appearance); the machine also has the facility to cut the 'cord' into small pieces known as 'blanks'.

There are basically only two methods of moulding parts in the department; one type of machine uses rubber in a 'blank' form, the other uses 'cord'.

The first method is known as Compression Moulding, and had been in use in the department since before the Second World War. The process is simply to place a piece of unvulcanised rubber, of the correct weight, into a metal mould, which is enclosed under pressure by two steam heated plates. The heat from these plates is sufficient to heat the mould and the rubber in the cavity, so that under a pressure of 100 p.s.i. the rubber will 'flow' and fill all the parts of the cavity. This 'flowing' of the rubber takes approx. 1 min. from the closure of the mould; the time varies with the thickness of the mould and quantity of rubber. The pressure and heat are however maintained for a further 9 minutes (on average), to 'cure' the compound i.e. transform it from a mixture of natural rubber, carbon and various additives into a material that has the normal elastic properties of rubbers. This method of producing rubber components appears somewhat 'primitive', and the basic process and machinery has changed very little in the past forty years.

The second method of moulding, Injection moulding, is adapted from techniques used in the plastics industry. In this process the rubber is fed into the moulding machine in 'cord' form. This method has a very much shorter cycle for parts production than the 10 minutes Compression Moulding cycle, because the machine preheats the rubber prior to injecting it into an electrically heated mould. Therefore, the rubber is partially cured before it enters the mould. In fact, on average, the rubber reamins in the mould for between 3/4 and 1.1/2 minutes. An added advantage is that because the machinery is more modern a large degree of operator control over the process has been eliminated.

All parts are moulded with more compound than is actually required for the finished parts, to ensure that the mould cavity is completely filled, and a 'whole' part is produced everytime. This in turn means that all parts have to undergo one or more finishing operations to remove this excess rubber, or "flash", as it is called. If we refer back to the diagram of the production process, we find that all the parts are sent to a stores area prior to the finishing operations. Here the moulding operators' production claims are checked, before the production figures are sent to the Bonus Department, where the wages are calculated.

The two moulding foremen on each shift are responsible for the control of all production and personnel to this stage in the process. One foreman is responsible for the Injection Moulding section and stores area, the other for the Compression Section and Barwell.
My first two months were spent with the foreman responsible for the injection moulding area.

The next operations are concerned with the removal of 'flash' or excess rubber. In the case of the majority of boots and dust covers the flash is removed either by hand trimming using scissors, or freeze trimming i.e. freezing the parts with liquid CO_2 and then bombarding them with small lead pellets to remove the flash. The choice of trimming method is often dictated by the position and thickness of the flash. Many of the seals however, are made on the injection moulding machines, and produced in a mat form. So in this case the seals have first to be removed from the mat by a 'clicking' or mechanical trimming machine.

The seals then have to be cut down to customer specified size on a lathe. The parts are fed into a chuck rotating in a vertical plane, and are trimmed to size by a blade moving in a horizontal plane. Parts are retained in the chuck by vacuum, which also pulls the parts against the chuck producing the rigidity of the part required during the cutting. As can be seen from the process diagram there are two basic types of lathe, named after the method of feeding the parts into the chuck. Hand lathes require an operator to feed the parts into the chuck, whilst an auto lathe performs this feeding operation automatically. The cutting is a precision operation with an average error of less than $\pm 0.01"$ being called for on most specifications. After these cutting or trimming operations some parts undergo further miscellaneous operations such as drilling or venting. Again the process is basically removal of excess rubber to customer specifications. The majority of parts are then washed prior to being inspected.

Inspection is arguably the most important part of the process, because of the critical role played by many of the parts when they are finally put to use. The quality standards require that each part be visually inspected for a number of faults. This is done by viewing the parts through an illuminated lens, giving a magnification of x2. The inspectors not only have to eliminate the scrap parts from the good parts, but are also required to separate the scrap into moulding or finishing scrap, i.e. decide whether the fault arose during the moulding or finishing operation. These scrap figures arose during the moulding or finishing operation. These scrap figures are then compiled into a report showing a weekly scrap figure for individual parts and an acummulative figure. This information is then used by the department for production/ quality control.

Following the 100% inspection of all parts, a check on the efficiency of the inspectors is carried out, known as a vendor check. This is intended as a sample check carried out not only for the customer, but also for the department, to ensure that individual inspectors are achieving the required standards. The vendor checker inspects a single sample of parts from each batch of inspected work, the size of the sample being determined by the quantity range of that batch. Depending on the results of this sample, the batch is either accepted or rejected. The rejection of batches runs at about 10%, and these rejected bacthes are returned to the inspector who performed the initial operation for reinspection.

Good parts are packed into cardboard boxes, and dispatched to the customer. On arrival at Automotive Products Limited, the parts are again sample checked, and each of the suppliers is assigned a grade. The grade is based on the % or number of batches that are passed as acceptable. In the latter half of 1971 Lockheed Department was rated as the lowest grade supplier. According to the definition of grades by the A.P. Group, this meant that the Department was : "A supplier who, on the basis of

Automotive Products Group Companys assessments of their current quality performance, urgently need to effect an improvement". This was another indication of part of the department's problems.

The details for this description were collected during the initial induction period, which also included brief visits to various service departments.

e.g. 1. Technical Department

The Technical Department was divided into four main areas, all of which were of varying importance to the Lockheed Department. These areas were :

1. Materials Evaluation - whose function was twofold, firstly development of new materials and secondly, the control and testing of all materials before they were used in the department.

2. Development - responsible for the development of prototype parts, in accordance with customer requests.

3. Process Control - this area supplied the Lockhhed Department with three full time process controllers, whose main function was to supply technical assistance on production problems.

4. Quality Control - for the Lockheed Department this was the most important area, since all the inspectors in the department were the responsibility of the quality control area. As well as providing the final inspection of all parts, there were also three 'roving' quality controllers whose function was to perform periodic checks on the parts at various stages of production.

The situation was to change, later. Firstly, the control of the final inspection section was assigned to the Lockheed Department, and the three roving quality controllers who were proving ineffective were phased out.

e.g.2. Production Control and Accounts Department.

Production Control was responsbile for planning and monitoring the output, keeping production records and customer liaison.

The Accounts Department produced two sets of information, a record of variable expenditure and a profit and loss account. The variable expenditure sheet for each department indicated the monthly actual expenditure, a monthly management planned expenditure figure, and also cummulative totals of actual and plan figures for the year to date. The profit and loss account, produced on a weekly basis, gave the total actual costs, the sales income, and therefore the profit/loss for the department.

3.3. The Departmental Accounts

By the end of November, a rough balance sheet for the department for 1971 was produced by the author. The variable costs were found from the monthly variable expenditure sheet mentioned above, and the figures for fixed costs were supplied by the chief accountant. A simple profit/loss account was compiled and used for the initial analysis. This is shown in Fig.3.3.

TOTAL SALES INCOME			£618,000
DIRECT MATERIALS COSTS	78,000		
LABOUR COSTS (INCL.NAT.INSUR).	420,000		
MAINTENANCE COSTS	122,000		
GEN. STORES ISSUES	23,000		
POWER COSTS	24,000		
TOTAL VARIABLE COSTS	667,000		
FIXED COSTS	255,000		
TOTAL COSTS	922,000		922,000
		LOSS	£304,000

FIG. 3.3.

For a short term solution to the problem of the loss there were three immediate courses of action available :-

1. Increase the prices by 50%
2. Reduce the total costs of production by 30%
3. Operate a combination of these two actions.

The price aspect had been under review for some time, since it had been discovered that the factory had inherited a department with a pricing structure that bore little relation to the actual cost of production.

My work was to be concentrated of reduction of costs, or to be more specific, reduction of variable costs. This was because a large portion of departmental fixed costs were allocations from factory fixed costs, and therefore savings in this area would tend to be spread across the factory rather than concentrated on the Lockheed Department.

From the figures in Fig. 3.3. it was obvious that the most important area of variable costs was labour, and for this reason one would expect that the majority of profit improvement ideas should involve labour reductions, either directly or indirectly.

CHAPTER 4

Evaluation of Ideas - I

Having generated and collected a number of potential cost saving ideas, as reported in Chapter 2, it then had to be decided which of them to pursue and ultimately to implement.

Broadly speaking, there were two main avenues along which research could be developed;

1. The general approach to the problem of the department's financial situation could be retained, by evaluating as many of the ideas for cost reduction as possible.

or

2. Research could be concentrated on one particular idea, or aspect of the department.

Mr.Air and Mr.A.A.Parr (Ind.Eng.Manager) suggested a possible line of research, which fell into the latter category.
The suggested project was a comparable analysis of Compression and Injection Moulding techniques, and all the associated implications for the department, if it were to totally adopt one method or the other.

Arguments for adopting this project included the considerable value of such information to the Company, when formulating development policy, and it might indicate whether present equipment was suited to present business. Furthermore, the project would usefully fill the three years available for research. However, against such a project was the fact that research was unlikely to have any immediate effect on the department's financial situation.

In an industrial environment this sort of decision as to which ideas/avenues to pursue, is frequently taken - perhaps after discussion - on the basis of the expertise of a few experienced people. This method is rarely, if ever, evaluated and there is no way of knowing whether the decisions were the best that could have been taken. In this case therefore, it was decided to make a quick and reasonably objective evaluation of all the ideas

suggested before accepting or discarding any.
It might have been instructive to simultaneously hold the traditional management-type discussion and compare the conclusions reached; but one important feature of the whole investigation, was the 'independent agent' role of the author, and at this stage it was feared that views expressed by management might have an undue influence on objectivity. When initial evaluation was completed, management would, of course, have the chance not only to comment, but to decide which ideas to implement.

There was still more than one way in which some kind of objective evaluation of ideas could be carried out. The Accounts Department or Industrial Engineering Department could have been asked to perform the evaluations using information available to them, or by getting the individuals who would be affected if the suggestions were implemented to make estimates. However, most of these suffered from one or both of the disadvantages mentioned above - lack of objectivity, and violation of the author's independent agent role. The evaluations were therefore carried out by the author himself, though of course much of the information needed came from people concerned in work relating to the various suggestions.

4.1. The Method of Evaluation

The method adopted to evaluate each idea can be summarised as follows :

1. List all arguments for and against each idea ("pros" and "cons").
2. Compile a list of facts required to quantify and place a financial value on each argument.
3. Collect the information and use it to quantify the argument.
4. Do the same for each argument and finally produce a quantified evaluation of the idea.

Stage one of the above method was accomplished by discussing each idea with interested parties, in order to ensure that a comprehensive list of arguments was obtained for each idea.

In any management structure one is likely to encounter some form of personal politics, which are likely to produce subjective rather than objective opinions on actions affecting an individual, or the area under his control. Therefore, where possible, ideas were discussed with those members of staff who were against ideas, as well as those who were in favour of them. In this way, it was hoped to gain a balanced view of an idea, and also an end evaluation that was acceptable to all 'interested parties'. Furthermore, such an approach offers a way of avoiding polarization of views, by involving individuals in a discussion of the arguments for and against.

So, even at this early stage, the importance of establishing working relationships with the management can be seen. Indeed, the adoption of this attitude, of asking people for their objections, helped to further these relationships by indicating that their knowledge and views were of importance, and were not being ignored. An example of the approach is seen in the idea to 'Eliminate the Part finished Stores and Storemen". This idea was discussed with the departmental manager, the production controller, the industrial engineering department, and the foreman responsible for the area - at least three of whom were opposed to the suggestion for various reasons.

In passing, it should be noted that it required a conscious effort on the part of the investigator to seek out opponents of ideas; most natural pressures make it easier and pleasanter to talk only to supporters.

Stage two of the method was the compilation of facts required to quantify each argument. Where possible the object was to place a financial value on the argument, though this was not always feasible e.g. where intengible benefits were anticipated.

Chapter 5. Departmental Scrap Models

5.1. Preliminary Study - Evaluation of scrap costs

At an early stage in the evaluation it became clear that many of the ideas had savings related to reductions in 'scrap'; this being the term used to describe those parts which for one reason or another did not conform with customer specifications and were therefore unsaleable. Furthermore, it was clear that little factual information was available in the department which would permit detailed costing of the scrap.

It was therefore decided to construct a 'scrap generation model' which would show at what stages scrap arose, and so the cost of producing it.

Scrap represents a financial loss in two ways :

(i) The material itself: because of the nature of the material the scrap produced after the vulcanising stage (in fact most of the scrap) cannot be re-used.

(ii) The cost of work carried out on the scrap parts; this arises at stages of the production process before the (faulty) operation which causes the part to become scrap; it can also arise after the stage at which it becomes scrap if it is not detected and remains in the system.

Two scrap models were therefore constructed, one for materials and one for labour, and these are shown in Figs. 5.1 and 5.2.

5.2. Construction of Departmental Scrap Models

Evaluation of the variable costs in scrap could not be obtained from the accounting system. The only other possible source of data was the costing system for individual parts, which was also rejected since it had been found by management to be inaccurate.

Weekly records were produced by the inspection section, showing the number of each type of part inspected, and what percentage were rejected for faults occurring during either moulding or finishing.

Therefore the department was aware of approximately how much scrap was being produced, but not the cost of doing so.

In order to provide estimates of the value of wasted variable costs, an analysis of inspection scrap data was applied to suitable models of relevant departmental variable costs.

The data used in the analysis was as follows :

Figures were taken from the weekly inspection scrap report, over a 32 week period (Weekending 9.4.71 to 26.11.71)

Total parts inspected	=	34,027,626
Total Good Parts	=	23,561,079
Total Scrap parts	=	10,466,607
Total Moulding Scrap Parts	=	7,025,980
Total Finishing Scrap Parts	=	3,441,627

These figures were then broken down into parts moulded by the two different moulding processes.

Injection Moulded parts :

Total parts inspected	=	24,876,561
Total Good Parts	=	18,114,679
Total Moulding Scrap parts	=	4,216,660
Total Scrap Parts	=	6,761,882
Total Finishing Scrap parts	=	2,545,222

Of the total parts produced 73% were produced on Injection machines, and the remaining 27% on Compression Machines.

Compression Moulded Parts.

Total parts inspected	=	9,151,065
Total Good parts	=	5,446,340
Total Scrap Parts	=	3,704,725
Total Moulding Scrap parts	=	2,809,320
Total Finishing Scrap parts	=	895,405

This data was then combined with labour and materials cost models to compute scrap costs. The models were based on the simple diagram of the production process shown in Fig. 3.2. in Chapter 3. The labour cost model, for example, was formed by :

1. Determining the number of operatives involved in each stage of production.
2. Finding from the Wages and Industrial Engineering Departments the average wages paid to operatives in each section.
3. Calculating the total wages bill for each section.

(The total wages paid according to the model were then checked against the annual wages detailed in the Departmental variables account)

The background data to the labour scrap cost model was as follows :

5.3. Labour Cost of Scrap Model

5.3.1. The Cost of Moulding Labour in scrap.

This cost was estimated by first calculating the total wages bill, for all direct and relevant indirect labour, for the two types of moulding. Then using the figure obtained in the analysis of inspection reports, i.e. in the case of Compression Moulding - 41% scrap the assumption made was that 41% of compression moulding labour was employed to produce scrap.

Compression Moulding

Total wages paid = £85,850 p.a.
+ £7,300 (Nat. Insurance + Employer's Liability Insurance).
= £93,100 p.a.

Labour Cost of Moulding Compression Scrap = 41% of £93,100
= £38,200 p.a.

Injection Moulding

Total wages paid = £72,400 p.a.
+ £5,150 (Nat.Ins. + E.L.I).
= £77,550 p.a.

Labour Cost of Moulding Injection Scrap = 27% of £77,550

= £21,000 p.a. *

* However, this figure does not include the unrecorded scrap, which is produced at the beginning and end of the shift. At the end of each shift the machines had to be filled with 'Virgin Rubber' to prevent material 'curing up' and machine jamming. Hence at the start of each shift, material is used to 'purge' the 'virgin rubber' from the machine. The moulding foreman estimated that each operator spent approximately 15 minutes a shift 'closing down' and 'starting up' the machines and producing scrap.

The labour cost of this time was estimated at - £2,600 p.a.

5.3.2. The Cost of Finishing Labour in Scrap

This cost was estimated by calculating the wages for all the finishing operations, then obtaining an estimate on the cost ratio of finishing Injection and Compression parts; both the Departmental Manager and the Finishing Foreman estimated this ratio as 1:1.5, i.e. the cost of finishing Compression parts was approximately 33% greater than Injection parts. Using this ratio, the total number of Compression parts was converted into 'Injection equivalent parts'. Finally, the total labour costs were then apportioned according to the percentage of Injection and Compression (Injection equivalent) parts, as a percentage of the total parts produced.

Division of Finishing labour costs

Total number of Compression parts = 9,151,065 (Section 5.2)

Total number of Injection equivalent parts. = 9,151,065 x 1.5
= 13,726,598

∴ Total Number of parts finished =

Total number of Injection parts	=	24,876,561
+ Total number of Compression/ (Injection Equivalent) parts	= +	13,726,598
	=	38,603,159

∴ Compression (Injection Equivalent) parts as a % of total parts finished = 36%.

Injection parts as a % of total parts finished = 64%

Now Total Costs of Finishing Labour = £132,100 p.a.

∴ <u>Labour cost of "finishing" Compression Scrap.</u>

= 41% of (36% of £132,100 p.a.)

= <u>£19,500 p.a.</u>

∴ <u>Labour cost of "finishing" Injection Scrap.</u>

= 27% of (64% of £132,100 p.a.)

= <u>£22,800 p.a.</u>

5.3.3. <u>The Cost of Inspection Labour in Scrap.</u>

Here it was assumed that the labour cost of inspecting a Compression part was the same as for inspecting an Injection part. Therefore total inspection labour costs were apportioned according to the total number of each type of parts inspected.

∴ <u>Labour cost of "inspecting" Compression Scrap.</u>

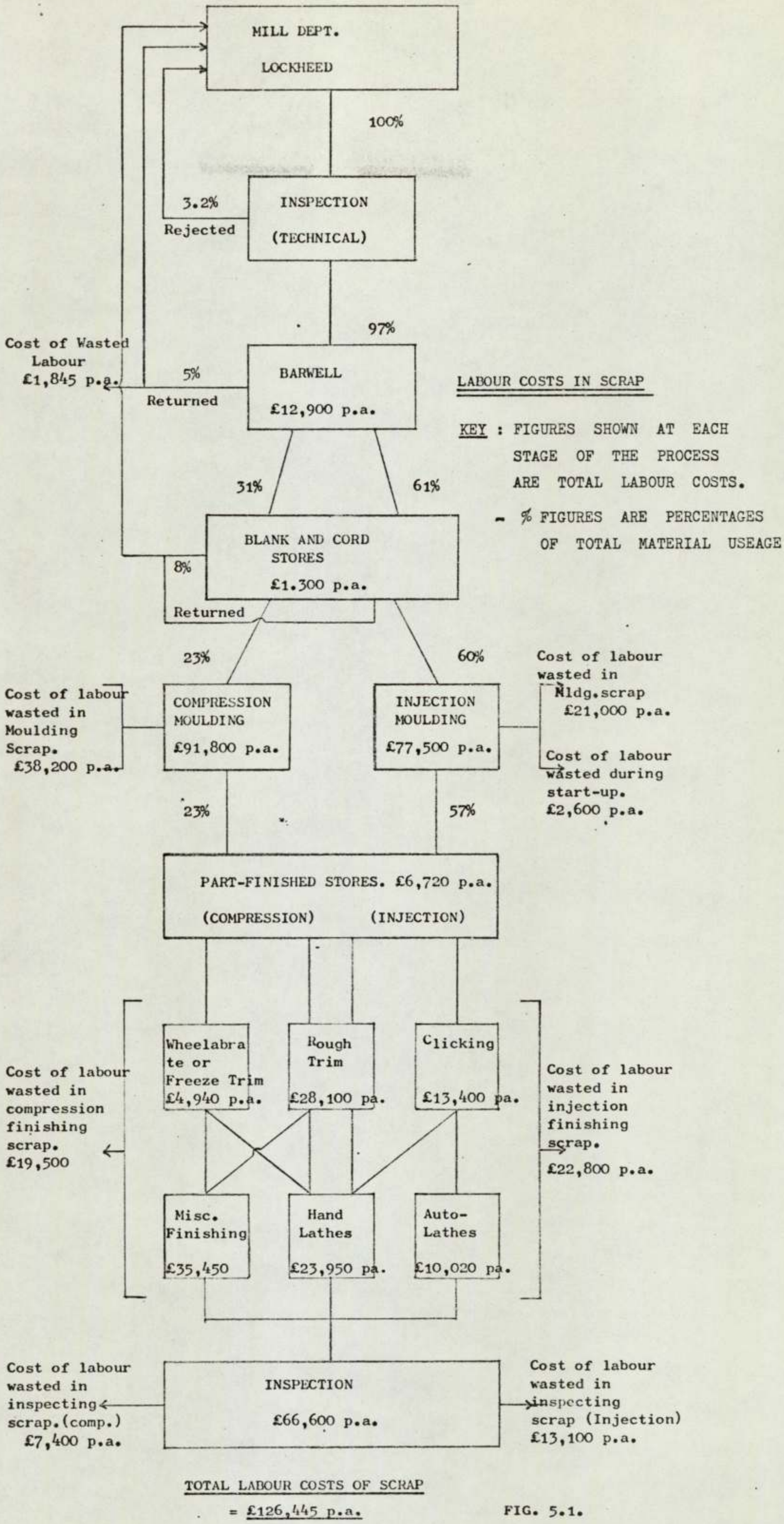
= 41% of (27% of £66,600 p.a.)

= <u>£7,400 p.a.</u>

∴ <u>Labour cost of "inspecting" Injection Scrap</u>

= 27% of (73% of £66,600 p.a.)

= <u>£13,100 p.a.</u>



<u>TOTAL LABOUR COSTS OF SCRAP</u>

= <u>£126,445 p.a.</u>

FIG. 5.1.

All this information is to be found in Fig.5.1., the 'Labour Scrap Model'. In the diagram it will be found that the scrap costs have in fact been broken down further to provide value of "Moulding and Finishing" scrap at each stage. This was achieved by using the figures from the tables of numbers of scrap parts (Section 5.2).

e.g. for Injection Scrap 63% of the Scrap is Moulding Scrap and 37% is Finishing Scrap.

5.4. Material Cost of Scrap Model

The "Materials Scrap Model" was constructed in a slightly different manner to the "Labour Model". It was basically a process of following the material input through the production process, then discovering where scrap is produced and why. During this investigation a number of areas were discovered where material was wasted, but the wastage was unrecorded. In such cases, in an attempt to obtain a complete picture, estimates were obtained from relevant personnel as to the magnitude of the wastage.

All the following data is to be found in Fig. 5.2.

5.4.1. Material rejected by the Technical Department.

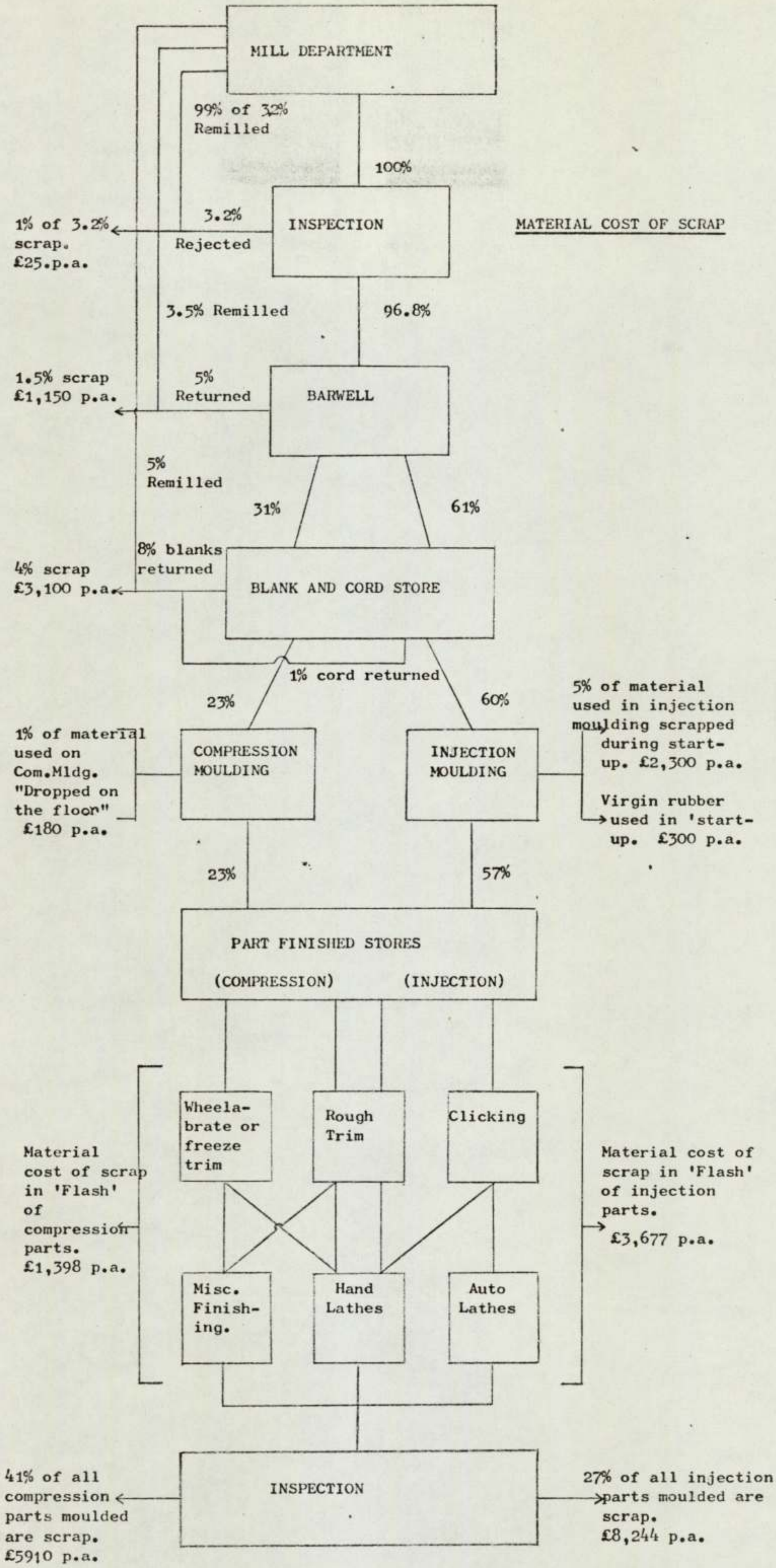
As a result of testing by the Technical Department, after mixing, 3.2% of mixed compound is rejected. Now 99% of this rejected compound is remilled, and a small loss is incurred, as a result of wasted labour. The remaining 1% is scrapped at a cost of £25 p.a, this figure being 1% of (3.2% of £77,500 p.a.). (£77,500 p.a. = total annual materials costs, from accounts sheet).

5.4.2. Cost of Material returned from the Barwell

This is due to the fact that a certain amount of compound is left in the machine after use. This has been estimated at 5% of all compound used on the Barwell, by a Barwell Foreman.

Of this 5% - 1.5% is scrapped, and 3.5% remilled.

Cost of the 1.5% is estimated at £1,150 p.a.



TOTAL MATERIAL COST OF SCRAP

= £26,259 p.a.

FIG. 5.2.

This £1,150 p.a. can be allocated £735 p.a. Injected Material and £415 p.a. Compression Material.

5.4.3. Material returned from the 'Blank and Cord' Stores.

At the 'Blank and Cord' Stores material may be returned due to ageing, incorrect blank size, scrap part production, etc. etc.
Statistics available were limited, but indicated that 9% of all compound is returned (8% blanks - 1% cord); 4% is then scrapped, the other 5% being remilled.

Hence the material cost in scrap was 4% of 9,100 kgm/week (figures from Barwell operators' work sheets).

i.e. $50 \times 9{,}100 \times \frac{4}{100}$ kgms @ 17 np/kgm.

Cost of material scrapped at this stage = £3,100 p.a.

(NOTE : account was also taken of wasted Barwell labour).

5.4.4. Material wasted on moulding machines :

Compression Operators dropping blanks on the floor.

Estimated 1% wastage at a cost of £180 p.a.

Material wasted by Edgwick operators at the start of each shift. At the end of each shift the machines have to be filled with virgin rubber to prevent the machines "curing up" and jamming. Hence at the start of each shift, compound is used in "cleaning" rubber from the machine - 5% of compound used on the Edgwicks is used in this manner, plus a quantity of virgin rubber.

Cost of 5% of total cord used on the Edgwicks

= £2,300 p.a.

Cost of virgin rubber was calculated from a figure for the total weight used per year (supplied by the Senior Foreman).

= £300 p.a.

5.4.5. Material used in the production of scrap parts.

The total material used in the two types of moulding was found from the Barwell operators work sheets. Then it was assumed that the material in scrap was equal to total percentage scrap of the two types of moulding.

We see from the material scrap diagram that 23% of the original total material mixed for the department is used in Compression Moulding.

In cost terms, this is equivalent to 23% of £77,500 p.a.

Similarly, the material costs for injection moulding = 57% of £77,500 p.a.

Cost of Material in Compression Scrap.

As mentioned above 23% of the original material input was used in Compression mouldings.

Of this 23% :

a) 4.4% is "flash" and removed at the "clicking and trimming" stage of finishing.

and b) 18.6% is used in the actual production of parts.

It was necessary to differentiate waste in the above manner, because a certain percentage of material is unavoidably wasted in "flash", whether the end product is a good or scrap part. However, if scrap savings are to be obtained, they can be done so in two ways :

a) For the same material input, good output can be increased by reducing scrap.

b) By reducing the material input, the same good output could be obtained if scrap was reduced.

In the first instance the amount of material wasted in "flash" remains the same, in the second instance materials savings from "flash" can be obtained, hence the need to have "flash" separated out.

Then the scrap costs were as follows :

1. Materials Costs of Scrap in "flash" of Compression Parts.

= 41% of (4.4% of £77,500 p.a.)

= £1,398 p.a.

2. Materials Costs of Scrap in Compression "parts"

= 41% of (18.6% of £77,500)

= £5,910 p.a.

3. Materials Costs of Scrap in "flash" of Injection Parts

= 27% of (17.6% of £77,500)

= £3,677 p.a.

4. Materials Costs of Scrap in Injection "Parts"

= 27% of (39.4% of £77,500)

= £8,244 p.a.

Summary

1. Cost of Scrap

From this analysis, it was estimated that the cost of labour and materials in scrap production was £152,704 p.a.

The breakdown of Scrap Costs was as follows :

	Injection	Compression
A. Labour Costs in Scrap		
Barwell Labour	£ 540	£ 1,305
Moulding Labour	£23,600	£38,200
Finishing Labour	£22,800	£19,500
Inspection Labour	£13,100	£ 7,400

	Injection	Compression
B. Material Costs in Scrap at :		
Barwell	£ 735	£ 415
Blank and Cord Stores	£ 345	£ 2,755
Moulding Machines and in "flash" etc.	£ 6,277	£ 1,578
In parts	£ 8,244	£ 5,910
TOTAL	£75,641	£77,063

Number of Parts actually produced at the required scrap rate

A certain amount of scrap is expected, and allowed for in the selling price of the parts. However, it was found during the analysis of the "scrap records" that only 50 out of a possible 460 parts, in production at the time, were being produced with scrap levels lower than those assigned to them. This gave an indication of the magnitude of the scrap problem.

Report

The two models and the information were made into a report and presented to management, who received it with some surprise, as they had been unaware of the magnitude of the costs. This was not surprising, since there was no information system capable of supplying the figures. The computer print-out of inspection records, did indicate a loss against standard costs in the region of £65,000 pa., caused by higher than standard scrap rates. However, since the standards at that time were considered inaccurate, the figure was largely ignored.

The invesyigation also revealed certain areas of wastage, not under effective management control. In such cases, where no recorded data were available, estimates had to be obtained from various members of staff as to the likely magnitude of these losses. These estimates are detailed in a full copy of the report in Appendix A. Once again a situation was encountered where relationships with staff became important, if valid or useful information was to be found, and it was felt that such information was needed to give the models "completeness".

Chapter 6 - Evaluation of Ideas - II

This chapter covers in detail the evaluation of six of the thirteen ideas generated during the initial stages of project work, followed by comments on approaches to management to assess their validity.

6.1. Evaluation of Ideas

Once the facts had been assembled, financial evaluation of the individual "Pros" and "Cons" for each idea was completed where possible. As mentioned at the end of Chapter 4, not all arguments can be financially evaluated, but this was done where possible, and the overall effect of an idea calculated.

Examples of evaluation now follow :

6.1.1. Replace Compression Moulds by Injection Moulds - for those Compression parts which can practically be moulded by Injection techniques.

Estimated Saving = £39,137 p.a.

This refers to the two basic types of moulding. In compression moulding the unvulcanised rubber is fed into the single cavity moulds by hand and the vulcanising process takes approximately 10 minutes. In injection moulding, rubber is fed automatically into a multi cavity mould and the vulcanising process takes approximately 1 minute. Comparison of the two processes is not direct since the relative advantages depend on the nature of the component. However, the Planning Department had been examining the possibility of replacement, and identified 16 parts currently made by compression moulding, which would be suitable for injection moulding. Nine of these 16 appeared on the inspection scrap reports during the period in which the 'scrap summary' was made. Hence the summary figures for comparative costs of the two types of moulding have been used to evaluate this idea.

Derivation of the above estimate

Pro's

1. Reduction in the cost of production of good parts.
2. Reduction in scrap levels, since scrap on Injection Moulding is less than on Compression Moulding.

Facts Required for, and used in Evaluation

1.0 Total number of good parts produced for the nine part numbers mentioned above

= 686,947 (in the 32 week period of the summary data).

1.1. Average number of good parts per part number

= 2,385 per week = 119,250 p.a. (50 weeks)

1.2. Assuming that all sixteen parts may be produced at this average rate - then the total number of good parts required per year

= 119,250 x 16 = 1,908,186 p.a.

1.3. Savings made per good part by changing to Injection Moulding

1.3.1 Average cost of labour, maintenance and power in a good Compression part = £0,02965. (See Appendix A).

1.3.2 Average cost of labour, maintenance and power in a good Injection part = £0.00914. (See Appendix A).

1.3.3 The difference in average production costs = the saving per good part

= £0.02057 per part

1.3.4 An assumption was made that the material cost would not change.

1.4 Savings on 1,908,186 good parts

= 1,908,186 x £0.02057

= £39,137 p.a. (as already indicated).

2. Reduction in scrap levels has been accounted for in this evaluation. However, there may also be improvement in the "morale" of the department if general scrap levels fell; this in turn might be beneficial.

Cons

1. Lockheed (i.e. Automotive Products) might not agree to pay for new Injection Moulds to replace the present moulds.

2. Extra Edgwick machines might be required.

Facts Required for, and used in Evaluation

1. The Planning Department selected only those parts with a sufficiently high monthly demand, to merit an Injection Mould, e.g. a minimum monthly call for 8,000 parts. Therefore, as most of the present moulds were due for replacement, it was anticipated that new Injection moulds would be forthcoming.

2. No extra Edgwicks are required since :-

2.1. Total number of parts which will have to be produced to obtain 2,385 good parts per week

= 13,000 parts per month with a 27% scrap rate.

2.2. Assuming there are four parts per charge, and an average operator working the machine on a 60 second cycle can produce 40 charges per hour

i.e. 4 x 40 = 160 parts per hour.

2.3. The time taken to produce 13,000 parts

= 81 hrs. = 4 days (working 2½ shifts per day).

2.4. Therefore, 16 part numbers would require 64 machine production days per month. Assuming 20 machine production days per month, approximately 3 extra machines would be sufficient to provide the necessary capacity. These machines were available, since two machines were permanently shut down, and a further two were available but not "commissioned".

∴ Total Cost of Implementation = 0.

6.1.2. Breakdown of the Finishing Department into smaller units. Estimated Gross Saving = £27,678 p.a.

Derivation of the above estimate

Pros.

1. Reduction in cost of finishing scrap.

Facts required for, and used in Evaluation

1. Estimated cost of finishing scrap = £41,517 p.a. (from scrap summary Appendix A).

1.1. Expected reduction in finishing scrap costs 2/3, as a result of dividing the finishing department into smaller units (from results in the Appendix below).

1.2. Possible saving = £27,678 p.a.

Cons

1. Cost of reorganisation of the department.

Note:- The saving does not include a figure for reorganisation, as the cost would depend to a certain extent upon exactly how the department was organised.

Appendix to the above idea No.2

This idea arose from a meeting between supervisors, at which mention was made of an experiment in the finishing department. In the experiment two parts were finished in isolated units, removed from the general finishing area, with a marked reduction in scrap.

1. Brief Summary of the Project on parts no. 37374 and 87366

By mid 1971, the situation with regard to customer arrears on part nos. 37374 and 87366 was so serious that the whole production process was subjected to a thorough examination.

In order to examine and improve the finishing process, all the machinery and operators involved were placed in an isolated unit under one foreman. The foreman's responsibility was to improve the standard of work, and produce a sense of involvement in the project. He was aided in his work by the Production Engineering Department who improved the finishing machinery. Their combined efforts resulted in a marked improvement of scrap standards, as can be seen from the graphs.

The experiment was seen to be a success, and the situation with regards to customer demands solved. Then, as orders started to fall, the units were returned to the finishing department. As can be seen from the graphs, once the experimental conditions were removed, a gradual worsening of the scrap standards occurred.

2. Results of the experiment.

2.1. Deductions from the graphs.

2.1.1. Part No. 37374

(i) From the % Total Scrap graph, making use of the trend curve, then :

a) The approximate scrap level before the experiment was 150%.

b) During the experiment the level was reduced to 27%.

c) After the unit was returned to normal production, the scrap level rose, and appears to find a level at 80%.

(ii) From the % Finished Scrap graph, again making use of the trend curve :

a) The approximate finishing scrap level before the experiment was 50%

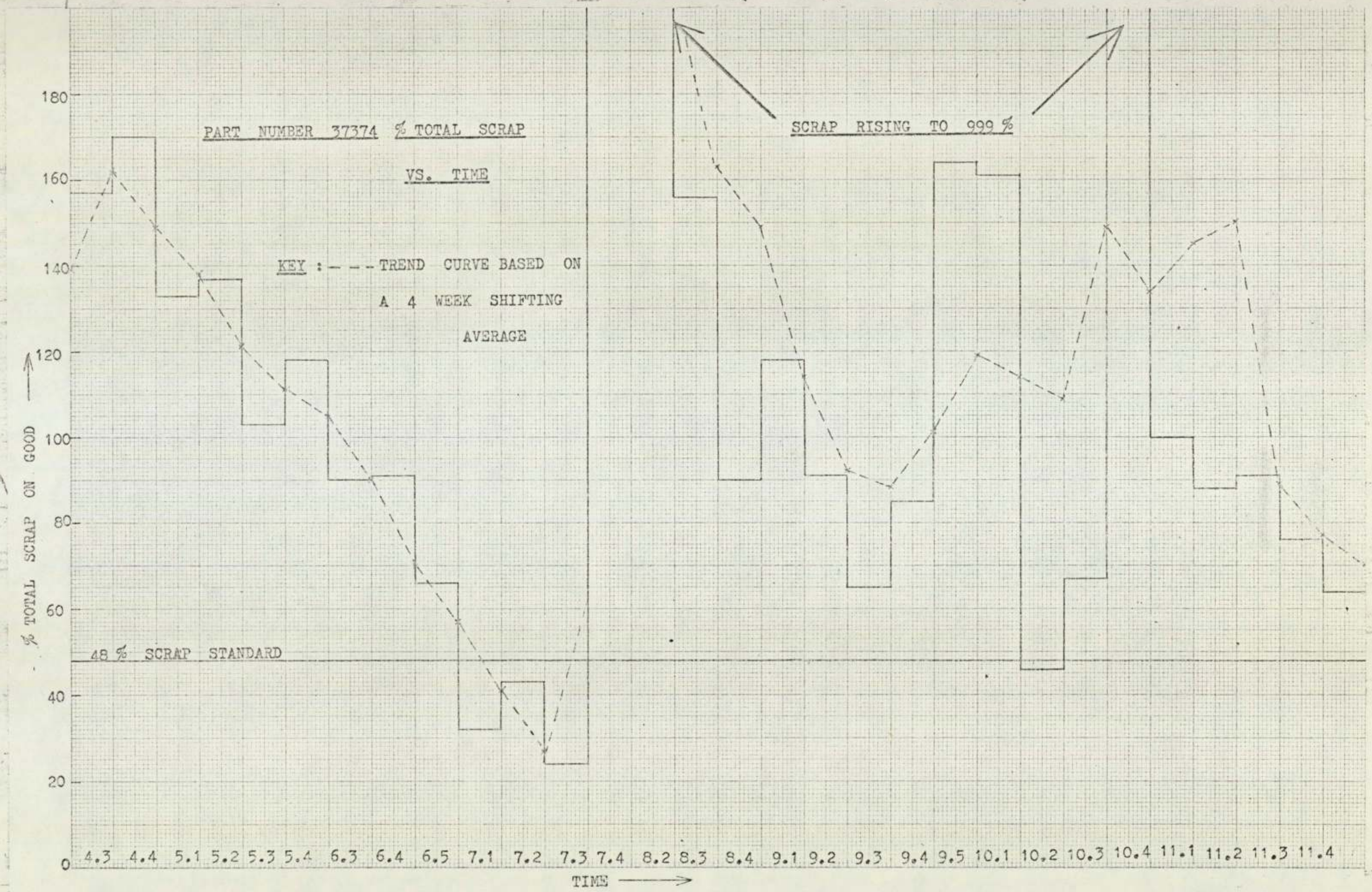
b) During the experiment finishing scrap was reduced to 8%

c) After the unit was returned to normal production, the scrap appears to level out at 15%.

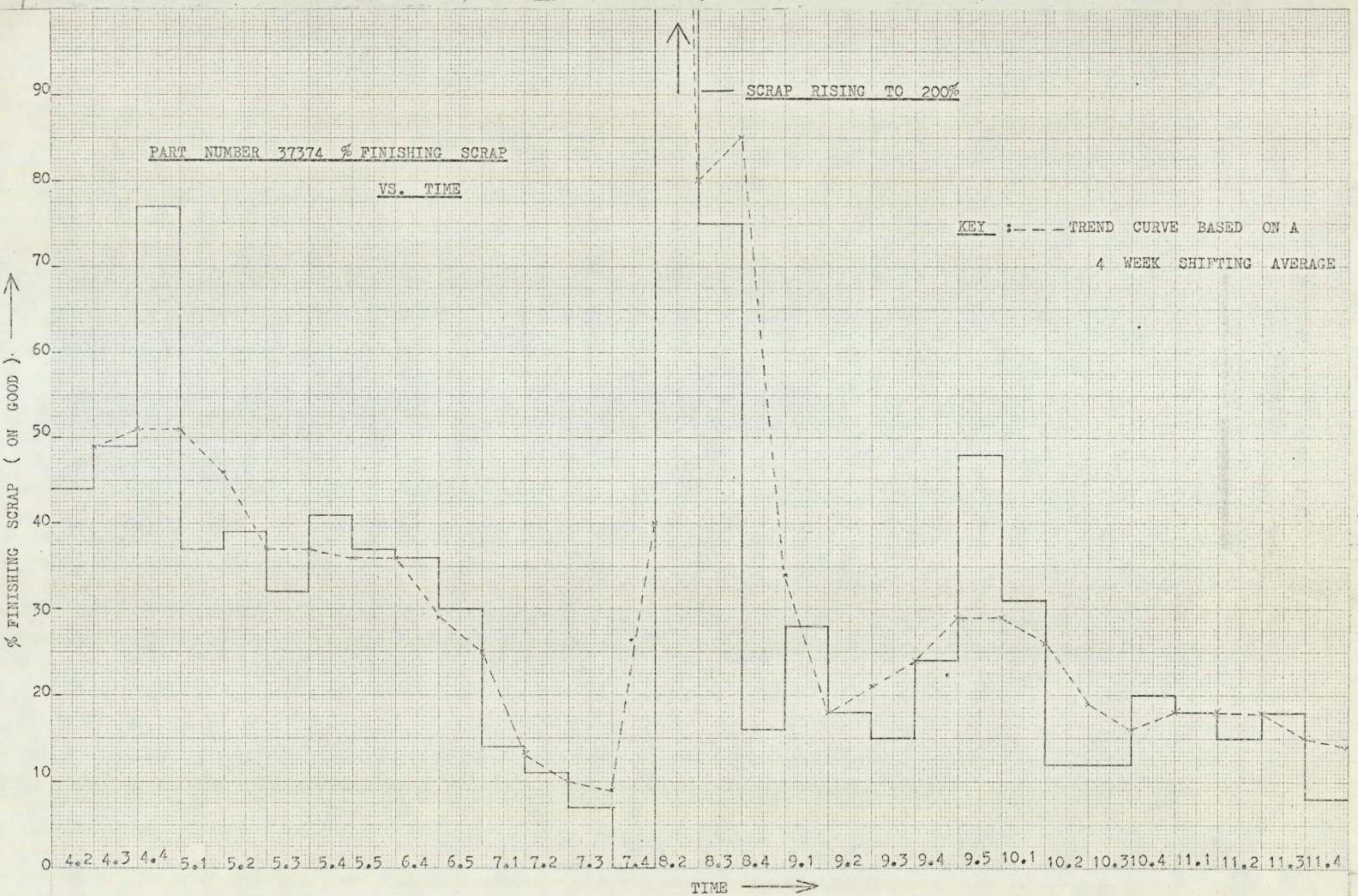
2.1.2. Part No. 87366.

Apply the same method as above.

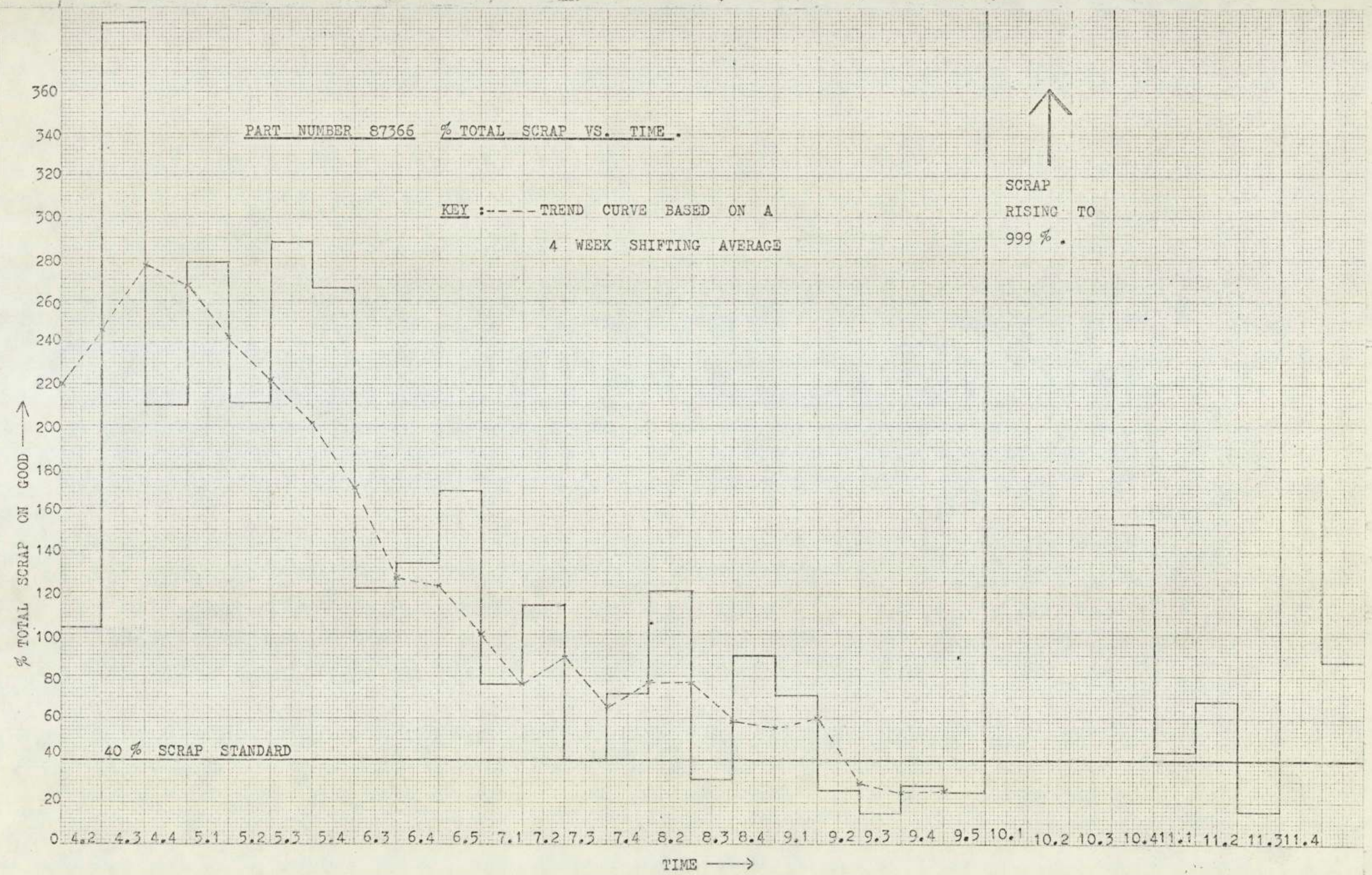
2.1.3. We can now tabulate the results in the following manner :-



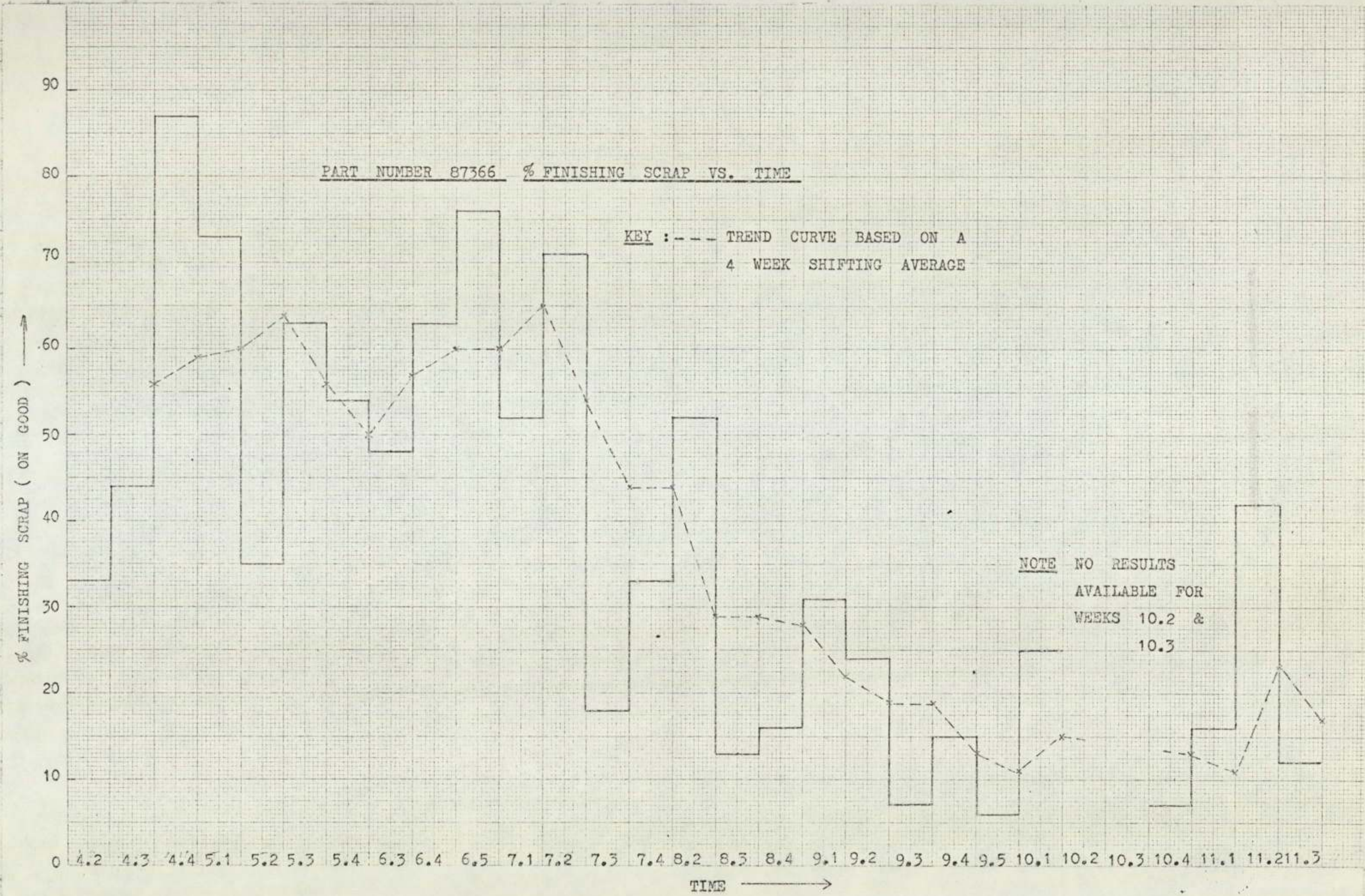
PART NUMBER 37374 % TOTAL SCRAP
VS. TIME
KEY : - - - TREND CURVE BASED ON
A 4 WEEK SHIFTING
AVERAGE
SCRAP RISING TO 999 %
48 % SCRAP STANDARD
% TOTAL SCRAP ON GOOD
0
20
40
60
80
100
120
140
160
180
4.3 4.4 5.1 5.2 5.3 5.4 6.3 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3 11.4
TIME



PART NUMBER 37374 % FINISHING SCRAP
VS. TIME
SCRAP RISING TO 200%
KEY : – – – TREND CURVE BASED ON A
4 WEEK SHIFTING AVERAGE
% FINISHING SCRAP (ON GOOD)
0
10
20
30
40
50
60
70
80
90
4.2 4.3 4.4 5.1 5.2 5.3 5.4 5.5 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3 11.4
TIME



PART NUMBER 87366 % TOTAL SCRAP VS. TIME .
KEY :- - - - TREND CURVE BASED ON A
4 WEEK SHIFTING AVERAGE
SCRAP
RISING TO
999 % .
40 % SCRAP STANDARD
% TOTAL SCRAP ON GOOD
TIME
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
4.2 4.3 4.4 5.1 5.2 5.3 5.4 6.3 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3 11.4


PART NUMBER 87366 % FINISHING SCRAP VS. TIME
KEY : - - - TREND CURVE BASED ON A 4 WEEK SHIFTING AVERAGE
NOTE NO RESULTS AVAILABLE FOR WEEKS 10.2 & 10.3
% FINISHING SCRAP (ON GOOD)
0
10
20
30
40
50
60
70
80
90
4.2 4.3 4.4 5.1 5.2 5.3 5.4 6.3 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3
TIME

Part no.	37374		87366	
	% Total Scrap	% Fin. Scrap	% Total Scrap	% Fin. Scrap
Before expt.	150%	50%	255%	57%
During "	27% (min)	8% (min)	80%	30%
After "	80%	15%	70%	18%

Very difficult to estimate the level of scrap, but the figure quoted is the average of the last four sets of figures.

2.1.4. Conclusions from results

2.1.4.1. For part no. 37374, the experiment reduced the total scrap by ½ and the finishing scrap by 2/3. However, if experimental conditions could have been maintained, the reductions on the original values could have been 5/6.

2.1.4.2. Interpretation of results for part no. 87366 was not so straightforward; as the trend for the scrap figures continued downwards after the experiment had finished (the experiment ended shortly after the factory's annual shutdown).

However, the results indicate that the experiment achieved a reduction of 2/3 on both Total and Finishing scrap.

3. Determination of the reasons for success.

Possible reasons for success are :

3.1. Improvements in machinery

3.2. Greater operator involvement in production standards and the production team.

3.3. Increased supervision.

3.4. The interest of the factory manager.

It is, however, almost impossible to quantify the individual contributions made by the above factors, from the available data.

4. Conclusions .

The implementation of any comparable situation on the finishing area as a whole is only likely to be successful if the same experimental conditions are obtained.

An attempt to use the isolation idea has been made, by the erection of wooden partitions. However, since these are only 5 ft. high, the department does not appear to be divided into sections.

This apparent lack of isolation, combined with the lack of intensive supervision is the probable reason for the fact that finishing scrap has not been significantly reduced.

So, if the idea is to be implemented more work should be done to define the optimum operating conditions.

6.1.3. Reduce Compression Moulding Scrap costs by regular inspection of parts during moulding.

Estimated Saving = £16,077 p.a.

This idea stemmed from lack of control over quality during the process; the existing system was such that scrap was only discovered after the final stage of production. By actually examining samples during the moulding process, it was hoped that corrective action could be taken before variable costs were wasted on producing scrap parts. It was hoped this could be achieved by a team of roving inspectors, who would not only inspect sample mouldings, but also perform some of the finishing operations and look for moulding faults that might not be apparent until the parts were finished.

Derivation of the above estimate

Pros

1. Reduction in the cost of compression moulding scrap.

Facts required for, and used in evaluation

1.1.1. Cost of compression moulding scrap from (Chapter 5)
= £55,342 p.a. (excluding maintenance costs).

1.1.2. Possible saving in costs due to the actions of the inspection team suggested in the 'cons' - 40% (As estimated by the senior moulding foreman).

Saving = £22,137 p.a. (for 40% reduction in scrap).

1.2.1. Cost of maintenance for Compression moulding
= £22,980 p.a.

1.2.3. Possible saving in maintenance costs due to reduction in scrap produced by inspection team.
= £9,190 p.a. (for 40% scrap reduction).

∴ Total Gross Saving = £31,327

Cons

1. Extra Inspectors required to inspect Compression samples.

Facts required for, an used in evaluation

1.1. The Senior Foreman estimated that three inspectors per shift could reduce moulding scrap by 40%.

1.2. The cost of employing three inspectors per shift, for 3 shifts per day, assuming the inspectors are paid at the top grade would be = (9 x 40 hours @ £0.74 per hr + shift allowances)x 52

= £15,250 p.a. = Total cost of idea.

Giving a Net Estimated Saving = £16,077 p.a.

6.1.4. Replace 22 hand lathes by 6 auto lathes.

Net Estimated Saving : £10,000 p.a. Capital Cost = £11,760

From an initial examination of the department, it was apparent that increased use of automatic lathes, where one man was responsible for three machines, would result in considerable savings in the wages of female operatives working the slower hand fed machines. Furthermore, using male labour it would be possible to run the machines for a 24 hrs per day.

Derivation of the above estimate

Pros

1. Saving in total labour costs with one man operating 3 automatic lathes.

2. By employing male labour, the auto lathes can be operated on a 3 shift systems.

Facts required for, and used in evaluation

1.1. Output from the hand lathes averages 71,000 parts per day from 26 lathes i.e. 2,700 parts per 8 hours.

1.2. Output from auto lathes averages 50,000 parts per 24 hours from 6 lathes (working $2\frac{1}{2}$ shifts) i.e. 3,300 parts per 8 hours.

1.3. 6 auto lathes operating 3 full eight hour shifts per day would cut 59,400 parts equivalent to $\frac{59,400}{2,700}$ = The output from 22 hand lathes.

1.4.1. Saving of labour cost of 22 female lathe operators = £20,030 p.a.

1.4.2. However the cost of 6 males working 3 shifts = £10,020 p.a.

1.4.3. Therefore we have an estimated net labour cost saving of £10,010 p.a.

(Note 1.4.2. Has not been included as a "con" in this idea because in this case all the "cons" are "one-off" capital cost expenses, and the two expenses have not been mixed to avoid misunderstanding).

Pro. 2 has already been used in the above evaluation see 1.3.

Cons

1. Cost of machinery and installation.

2. Limitations on the type of parts suitable for using in auto lathes.

3. Training cost of setter-operators.

4. Setting times.

Facts required for, and used in evaluation

1.1. Cost of 1 auto lathe including installation
= £1,500 (figures from the Assistant Dept. Manager who had been responsible for the purchase of those "autos" in use).

1.2. Cost of 6 auto lathes = £9,000

2. Limitations to the type of parts cut on the present suto lathe, was due to the fact that parts were held in the chuck by vacuum. This meant that those parts designed with holes in them were unsuited to this type of machine. However, there were mechanical types of auto lathe in use at the Girling factory, which accepted most types of parts. It was therefore recognised that, before any transfer could take place, an investigation was needed as to the type of machine required. This information was obtained from the finishing foreman whose "anti" views were of considerable importance.

3.1. Training a setter-operator was expected to take 10-18 weeks (as estimated by the Training Dept).

3.2. The cost of training was thus estimated as 6 x 14 week wages per operator = £2,760.

4. Again discussion with the finishing foreman produced an important point, that of "setting up times".

4.1. Hand lathe letting up time = 5 - 15 minutes.

4.2. Auto lathe setting up time = 15 - 60 minutes.

This was because with the automatic machine not only the chuck, but also parts of the automatic feeding mechanism had to be changed. Thus provision would have to be made to ensure that auto lathes would 'run' for a sufficient time, to justify the time spent "setting-up" the machine.

Total Estimated Capital Cost = £11,760

At this stage the application of standard accounting techniques for evaluating capital investment was considered, but deferred until management reaction to the project had been obtained.

6.1.5. Eliminate the "Part-finished stores and storemen"
Estimated Saving - NIL

The idea was that "part finished stores" should be removed from the department. As it turned out it was a rather poor idea as discussions with "interested parties" were to indicate, as the "function" could not be eliminated.

Derivation of the above estimate

Pros

1. Eliminate the labour cost of storemen.

2. Possible income could be gained from renting out the stores area to another department.

3. Possible reduction in Lockheed Department rates, as a result of reducing the floor space used.

Facts required for, and used in evaluation

1. Cost of part finished storemen
= £6,720 p.a. (From Labour Scrap Model).

2. The use of the stores area was limited, because it was in the centre of the general production area of the department. Hence it was unlikely that any other department would want to rent the area.

3.1. The sq. footage of the stores = 2,300 sq.ft.

3.2. The rates paid = 50p/sq.ft.

3.3. Potential Saving = £1,150 p.a.

Cons

As mentioned in Chapter 4, this idea was discussed with a number of departmental staff and the industrial engineering dept. and they came up with the following arguments against.

1. The part finished stores is a check stage in the production process. The moulding operator's work is counted, and the information is then used by the Wages Section to compile the wages. Thus, if the stores were eliminated then either :

   A. Labour would be required to check the operator's work, or

   B. The wages system would need alteration.

2. The stores provides an area in which parts are kept between stages of production. Thus, unless part finished stocks are reduced, this area will continue to be required for storage.

Conclusion. Because of the ramifications of a change in the wages system it was assumed that a change would be unacceptable. It was unlikely that the labour required for checking operators work claims would be less than that already employed. Also, since the storage area is required somewhere within the department, it is unlikely that any saving would be obtained from "Pros" 2 and 3. Hence estimated saving from the idea was nil.

6.1.6. Reduce scrap costs, by inspecting all parts after moulding before finishing is performed.

Estimated Saving =-£27,580 p.a.(LOSS)

The intention of the above idea was to remove all the moulding scrap from the system before any finishing or inspection labour was wasted on it. In order to ensure that all scrap was removed, a 100% inspection of parts would be required, after moulding, prior to finishing.

Derivation of the above estimate

Pros

1. Reduction in the costs of labour wasted on finishing and inspecting moulding scrap.

2. Reduction of moulding scrap reaching the finishing and inspection departments may have beneficial effects on operator morale.

Facts required for, and used in evaluation.

1.1. Labour costs of finishing and inspecting moulding scrap (Taken from the scrap models) Chapter 5.

1.1.1. Labour cost of finishing compression moulding scrap = £14,800 p.a.

1.1.2. Labour cost of finishing injection moulding scrap

= £13,350 p.a.

1.1.3. Total cost of finishing moulding scrap = £28,150 p.a.

1.2.1. Labour cost of inspecting compression moulding scrap = £5,620 p.a.

1.2.2. Labour cost of inspecting injection moulding scrap = £5,250 p.a.

1.2.3. Total cost of inspecting moulding scrap = £10,870 p.a.

Total cost of finishing and inspecting moulding scrap = £39,020 p.a. (Total Estimated Saving)

2. This type of "pro" cannot be assigned financial value.

Cons

1. Extra inspectors would be required to inspect parts after moulding.

2. Possible difficulty of siting an inspection area.

Facts required for, and used in evaluation.

1.1. The toal number of parts to be inspected was equal to the number of parts being inspected as the final operation. It was therefore assumed that a labour force equal to the existing inspection section would be required.

1.2. Present cost of inspection labour = £66,600 p.a. (from the labour scrap model).

1.3. Total cost of extra inspectors = £66,600 p.a.

At this stage of evaluation the project shows a loss of £27,850 (£39,020 - £66,600) pa.

2. In view of the size of the estimated loss resulting from the above argument, no estimates were made as to possible costs of siting such an area.

Only six examples of evaluation have been given as this seems sufficient to indicate the approach adopted. These six with a further seven evaluated and seven unevaluated ideas are to be found in Appendix A, which is a copy of the report submitted to Management. The form of presentation is slightly different in the report, as it was assumed that management were familiar with the department and the process. (A brief description of the other seven ideas is provided in Appendix A).

6.2. Examination of Evaluations prior to presentation to Industrial Supervision.

An initial evaluation of ideas generated was completed by the end of February 1972. At this stage a supervisors meeting was held at the factory between Mr.Parr, the Industrial Engineering Manager, Mr.Tate and myself. The purpose of the meeting was to examine in some detail the initial evaluation of cost savings ideas. The intention was that Mr.Parr would examine the report and discuss with us those points which he felt were incorrect or inaccurate. These points were noted and alterations or corrections made in the report.

This approach was adopted in preference to submitting the report directly to Mr. Air for two reasons :

1. Top management time was considered to be at a premium, and not to be taken up by trying to find errors in detail of evaluations. Therefore, if an accurate report was presented, then discussion time could be devoted to the implications of the recommendations.

2. In order to attain the required standard of accuracy, the details had to be examined by a senior manager whose judgements in the field were acceptable to Mr.Air. The Industrial Engineering Manager was such a person.

   At his request a number of points were re-examined and certain corrections and alterations made to the evaluations, which indicated some imperfections in the evaluations. However, examples of the use of the approach stood up to rigorous examination reasonably well, as criticisms tended to be on points of detail rather than methods. e.g. Mr.Parr suggested that in certain cases where allowances had made for ineffective transfers of labour, the factory situation was now such that they could be totally effective. i.e. labour saving from re-deployment could be 100% rather than an assumed 80%. In certain cases he requested and suggested possible 'cross-checks' on 'scrap' data.

6.3. Secondment to the Industrial Engineering Department

Shortly after the supervisors meeting mentioned above, Mr.Parr requested that I help in an Ind.Eng. Exercise on manning levels in the Lockheed Department. Therefore I was faced with the problem of interrupting my research work, or continuing my project and possibly incurring Mr.Parr's displeasure by refusing to give assistance.

Although the investigation was not directly related to my project work, I felt there were certain benefits to be gained from offering co-operation. Firstly, the exercise was likely to produce information that would be useful in a follow up of one or more of the cost saving ideas. Secondly, the work might lead indirectly to the generation of other profit improvement ideas, or the exercise itself might indicate areas for profit improvement. Thirdly, by co-operating with the Industrial Engineering Department, I was likely to improve working relationships with the Industrial Engineering Manager, and a large number of his subordinates. As the department had been an important source of information for project evaluation, and was likely to continue to be so, a feeling of 'mutual understanding' and co-operation seemed likely to promote an improved flow of information. Finally, and most important, the exercise would provide the opportunity to check, from an independent source, the conclusions drawn to date.

The project, which lasted four weeks, consisted mainly of analysis of parts produced by the department into groups, defined by similar production processes. Then using monthly customer requirements for these 'groups', theoretical manning levels were produced from piece work rates. As might be expected these estimated manning levels were much lower than those actually existing in the department. Hence, assuming that data used to compile the theoretical figures were correct, labour was ineffectively used. Also the exercise showed that high scrap rates were inflating the labour requirements. Thus the general conclusions drawn were that labour could be reduced by improved efficiency and control over scrap. Although it must be noted that the exercise produced general pointers, and did not indicate where and how cost reduction actions should be taken.

Therefore, the exercise tended to support the initial finding of my work; namely, that one way to profit improvement in the department was by reduced labour costs. In fact, information produced by the exercise appeared to be of use to project work, and working relationships were to prove useful later, when project implementation was attempted with the co-operation of certain members of the department. So the exercise proved an interesting and useful deviation from the main line of approach of the project.

6.4. Presentations of corrected Evaluations

Having completed this exercise, and made the suggested corrections to the first cost saving report, the evaluations were re-submitted to Mr.Parr for final approval. Once this was obtained Mr.Air was approached to ascertain his views on the final presentation of the information. He requested a brief summary of the findings, and recommendations for actions on individual ideas, as well as a detailed report on the evaluation of individual ideas. (As mentioned at the end of 6.1 this report can be found in Appendix A).

These recommendations were discussed at a supervisors meeting. The meeting took the form of a presentation of the content of the report, and the reasons for actions recommended on individual ideas.

Chapter 7 - The Presentation of the Profit Improvement Ideas.

We now had some evaluated ideas which indicated possible areas where savings could be made. Obviously, a management decision was required before the next phase of work could begin. We were faced with two problems : firstly, which of the ideas should form the basis of the next stage of research? Secondly, how were we to get management to make the decisions?

This chapter is concerned with the presentation of profit improvement ideas to management. This short period in the project's history has several important features :

(i) It indirectly highlighted the problems of industrial supervision.

(ii) The value of the work done was placed into a departmental perspective, rather than considered in isolation.

(iii) Comments from the Industrial Supervisor highlighted possible short comings of the approach adopted.

(iv) Most important, decisions were made on the next phase of work and the 'management' of this phase.

7.1. The Method of Presentation

The work had reached an important stage, and in Mr.Tate's experience, the manner in which recommendations were presented prior to discussions was important. There were a number of possible options, and we chose to hold a meeting. In doing so, various ways of conducting it were considered. e.g. i. We could assume that the evaluations report had been read and digested by Mr.Air, and merely attempt to discuss the proposed recommendations. Such an approach would tend to reduce the scope of Mr.Air's role as Industrial Supervisor, by attempting to preclude any comments on the way in which the work had been performed. Also, could we expect Mr.Air to have read the report in sufficient details to accept it without comment?

ii. The report could be 'read through' at the meeting, thereby giving Mr.Air the oportunity to raise points in detail. This approach would undoubtably entail a long meeting, which in turn might limit the discussion of recommendations and possibly delay decisions.

iii. We finally decided on a third option, that of a 'flip-chart' presentation. This would allow the author to run through the ideas giving an outline of savings; allowing Mr.Air the opportunity to question detail, whilst retaining a reasonable degree of control over the time spent on individual areas. It was also hoped that the actual visual form of the presentation would increase the impact of the report, and provide motivation for reaching decisions.

7.2. Presentation Number 1

It was agreed that a meeting of supervisors be held at the factory to discuss the evaluations produced and the recommendations arising from them. As mentioned above, the meeting was to take the form of a 'flip-chart' presentation with the author providing a suitable commentary. The presentation was to consist of four main sections:

A. Financial Situation of the Department.
B. Evaluation of Projects.
C. Approach adopted during evaluation.
D. Recommendations.

Section A was a statement of the departmental profit and loss account, indicating the magnitude of the loss and stressing the importance of variable cost, and in particular labour cost, reduction.

Section B was a brief description of all the ideas mentioned in the previously circulated report (End Chap.6) with an outline of the savings and losses of those ideas that had been evaluated.

Section C contained an outline of the approach to evaluation of ideas, similar to that given in Chap.3 Section 1. The section also gave an indication of the implications and magnitude of double counting of savings, if ideas were to be implemented without further research. This is a point that hasn't yet been mentioned, as it does not become significant until we begin to examine the possible implementation of various ideas.

In any large list of ideas for savings in a given area, one is likely to find more than one idea acting on a particular cost element of the area. e.g. we have produced at least three ideas that either directly or indirectly make savings by reducing finishing labour. Now during the initial evaluation each idea in turn is considered to act on the area in isolation, and the savings estimated accordingly. However, if all three ideas were to be implemented, then the savings for two of the ideas must be considered to act on an area already affected by the implementation of the previous idea. Therefore, if we are expecting labour reductions from all three ideas, then at least two of the savings must be reduced to eliminate double counting.

Again this is a simple point, and should certainly be part of any programme of evaluation of ideas involving a series of changes. It may also be necessary to examine the effects of variation in the order of implementation of ideas. Although the total savings from a given set of ideas will remain constant whatever the order of implementation, it is possible that the last idea in a particular arrangement may have only a small saving. Therefore, if one or more ideas are to be omitted for this reason, the total cost of implementation, or even the likely 'political' consequences of various combinations, must be compared with total savings, before deciding on implementation.

This point is further discussed in the manual on 'Profit Improvement Opportunity Approach' (Appendix G.)

Finally section D outlined possible alternatives for the next stages of work, which were to be discussed at the meeting. A number of options were available as possible ways to continue research; these were in general :

i) Assemble a number of cost reduction projects into a programme for implementation, and concern myself with the overall success of the programme.

ii) Assemble the programme as above, but concern myself with only one or two projects with large savings, but which required further research before implementation could be considered.

iii) Adopt the idea suggested by Mr.Air and Mr.Parr - A Comparative Evaluation of Compression and Injection Moulding Processes. The 'Pros' and 'Cons' of this idea were briefly discussed in the report at the end of the previous chapter, and it was felt that while it represented useful long term research for the department, the short term financial liability of the department was of overriding importance.

Therefore, we felt that the first two options represented more useful areas of work.

This then was the outline of the intended presentation, to be given to a meeting of all supervisors, at the factory. My two academic supervisors arrived at the factory, only to find that at the last minute the Factory Manager, Mr.Air was called to Manchester on divisional business and the meeting had to be cancelled. It later transpited this was a fortunate postponement, which resulted in a useful reappraisal of the work done.

However this last minute cancellation served to highlight one of the problems of industrial supervision. These problems are discussed in a later section of this chapter when the work done is examined.

The solution to the problem of holding a supervisors meeting, in which we could have the undivided attention of the Factory Manager, was produced by Mr.Air. He suggested that the meetings be held in a hotel mid-way between factory and university. This proved to be a satisfactory arrangement.

7.3. Review of the overall prospects for the Department.

The postponement of the meeting offered an opportunity to further rehearse presentation techniques and commentary. As part of these rehearsals the intended presentation was given to Professor Cook. His immediate comment was that the department was still 'at risk'. Although it appeared that we could make substantial savings, reducing the £300,000 p.a. loss by some £100,000 p.a., we would still be faced with a £200,000 p.a. deficit. Therefore we had only produced a partial solution to the problem.

In fact in different or more normal circumstances, if the loss could not be fully eliminated, and replaced by a viable profit, then closure of the department would be preferable to continued operation at a reduced loss. The situation therefore needed revision, to determine whether we might realistically expect to eliminate the departmental loss.

This review of the prospects of the department had to be performed very quickly, since it was intended that the original presentation be rewritten to cover the points raised by Professor Cook, and then presented at the rearranged supervisors meeting three days later.

Firstly the profit/loss account was rewritten in the simplified form shown below :

	£'000's
LABOUR COSTS (INC.MAINTENANCE LABOUR)	498
MATERIALS COSTS	95
MAINT. MATERIALS COSTS	42
POWER	23
DIRECT COSTS SUB TOTAL	658
OVERHEADS	270
TOTAL COSTS	928
REVENUE	627
LOSS	301

Then it was calculated that to eliminate the departmental loss the following would have to be achieved:

- Assuming that Revenue remained constant, a reduction of £214,000 p.a. in Direct Costs would suffice, provided overheads remained at 41% of Direct Costs. This was equivalent to a 43% cut in manpower, or a 32.5% cut in Direct Costs.
However, the underlying assumption that overheads would reduce in direct proportion to direct costs was somewhat doubtful, since the costs were 'allocated' rather than 'actual'. It was of course possible that this would be partially offset by an increase in revenue, which had been assumed constant.

Thus the simple analysis had to indicate that a saving of £214,000 p.a. in direct costs were possible, which in turn meant that a further saving of £100,000 p.a. had to be found to supplement the savings from ideas already evaluated.

Unevaluated opportunities were therefore examined, and these appeared to fall into four main categories:

1. Spin-off effects from evaluated projects - i.e. possible beneficial side effects resulting from implementation of a project.
2. Current projects, which had not been evaluated.
3. Defined ideas not yet evaluated.
4. Undefined ideas for Cost Reduction.

These four were examined in detail to see whether they would yield the extra £100,000 p.a.

7.3.1. Spin-off' effects from evaluated projects (see Fig.7.1).

Three of the ideas already evaluated indicated that they might contribute extra or spin-off savings after implementation.
e.g. Idea 9 - The improved use of Technical Data by the Production Foreman.

'PROS'

1. Elimination of wasted production time due to poor compound.
2. Saving on material wasted in production of scrap due to poor compound.

'CONS'

1. The foreman may not be able to use the information correctly.

SPIN-OFFS COULD CONTRIBUTE ABOUT £57,000 PA.

HYPOTHESIS	POSSIBLE VALUE £,000's P.A.
I Improve the use of technical data	
- Reduce scrap by 10% through better test specification	10
- Reduce moulding scrap by 10% by improved press operation.	10
- Reduce press operators by 10% through improved press speeds.	17
J Replace Hand-lathes by auto-lathes.	
- Reduce finishing scrap for compression parts from 1/6 of good moulded parts to 1/9 of good moulded parts. (as for injection, where most parts are on auto lathes). Thus reducing compression scrap from 40% to 36%.	7
M Re-group the finishing department into smaller units.	
- Improve output by 10% due to higher morale and less movement.	13
	57

FIGURE 7.1.

This idea might produce the following spin-off effects :

a) A reduction of scrap through better test specifications used by the Material Control Laboratory, resulting from the feedback of data from the production foreman.

b) A reduction of moulding scrap by improved press operation.

c) A reduction in moulding labour might be obtained through improved press speeds, arising from information gained from a) and b).

7.3.2. <u>Current Projects.</u> i.e. ideas being research by 'others' (see fig. 7.2).

e.g. At that time the University of Birmingham were undertaking research into improving methods and conditions of inspection, and it was hoped that savings in inspection labour would be possible, as a result of improved productivity.

7.3.3. <u>Defined Ideas not yet evaluated</u> (see fig.7.2)

These were ideas contained in the report mentioned at the end of the previous chapter, which had not been evaluated. They were examined to see whether estimated savings could be made for them.

7.3.4. <u>Undefined Ideas for Cost Reduction</u> (see fig.7.2)

To evaluate any potential savings for this category a new idea had to be generated, which leads to a rather paradoxical situation, since we are considering "undefined ideas" as a potential source of cost reduction. Figs. 7.1 and 7.2 are in fact extracts from the revised presentation, and indicate that further savings of £103,000 p.a. might be obtained. It must be remembered that this was something of a "paper-exercise" to demonstrate that the elimination of the departmental loss was not an unrealistic target. Another interesting point is that this 'paper-exercise' to 'close the gap' was performed in one afternoon, and produced 'paper-savings' equal to those in the initial investigation which had taken some 6 months.

OTHER UNEVALUATED OPPORTUNITIES COULD CONTRIBUTE

A FURTHER £46,000 P.A.

	POSSIBLE VALUE £,000's P.A.
CURRENT PROJECTS.	
Reduce inspectors by 1/3 by re-training	20
DEFINED IDEAS NOT YET EVALUATED	
- Inspect more compound more thoroughly	?
- Train operators to inspect their own work	?
- Increase finishing machine utilisation by better scheduling reducing finishing operators by 10%	6
UNDEFINED IDEAS	
- Convert a further 12½% of compression parts to injection.	20
	46

FIGURE 7.2.

However, it must be said that the 'paper-savings' could not have been estimated without the hdp of data collected during the investigation period, and the cost models.

The work had now been placed into some sort of departmental perspective, which had until that time been overlooked. It was therefore felt that the cancellation of the first supervisors meeting was a somewhat fortunate occurence, as the revised presentation tended to strengthen our proposals.

7.4. Presentation Number 2.

The format of the original presentation was now revised, in the light of the new view of the work, and its relation to the possible future of the department. (copies of the 'flip-chart' exhibits are to be found in Appendix B).

The first aim of the presentation was to indicate that the financial goal of loss elimination was realistic. Then, providing this was accepted, the ideas evaluated to date could make a considerable contribution to achieving that aim. Because the approach adopted had certain weaknesses, these were indicated, organisational recommendations were made to overcome them and develop a system for implementation of profit improvement opportunities.

7.4.1. Strengths and Weaknesses of the Independent Agent Approach to profit improvement ideas.

Before discussing the strengths and weaknesses of the approach, it might be useful to define the 'approach'. It can be considered in 7 stages as follows :

1. Collection and generation of ideas.
2. Listing the 'Pros' and 'Cons' for each idea.
3. Listing the facts required for financial evaluation of 'Pros' and 'Cons'.
4. Collection of facts required.
5. Evaluation of 'Pros' and 'Cons' and net effects of each idea.
6. Examination of cost saving ideas for double counting.
7. Compilation of suitable ideas into a programme for implementation.

The strengths have been mentioned earlier, but can be briefly states as :

1. Free thinking from usual constraints.
2. Involves personnel concerned, when discussing 'pros' and 'cons'.
3. Introduces a disciplined approach in quantifying 'pros' and 'cons' in a systematic and rigorous way.

These points have been restated because certain aspects of the approach came in for criticism during the presentation of recommendations.

Most of the weaknesses have not been indicated until now, because they tend to be related to theadministration and implementation of the approach, rather than the mechanics of evaluation.
The weaknesses are as follows :

1. Double counting of benefits can occur. This was mentioned in the earlier description of the first presentation. In fact, calculations indicated that the estimated savings of £114,000 p.a., expected if all ideas were eventually implemented, would fall by some £7,600 p.a. as a result of the elimination of double counting of savings. The major area of saving that was affected was the inspection labour savings, where the total savings for individual projects was £15,100 p.a. This figure dropped to £9,900 p.a. after double counting had been eliminated.

2. Research effort can be misallocated, unless all research within the area/department is carefully co-ordinated. e.g. At the time some work was being done by the Industrial Engineering Department to improve some of the hand-lathes, while the authors work had indicated that savings were to be made by replacing hand-lathes with auto-lathes.

3. Poor high level planning might result, unless the 'agent' can communicate his results to a sufficiently high level. e.g. It might have been possible that a decision to close the department could have been made without prior knowledge of the authors work.

4. The work can lead to operator or manager resistance, unless full involvement, understanding, and acceptance is secured from the beginning.

7.4.2. Recommendations to remedy the weaknesses in the Approach

Having identified possible weaknesses the following recommendations were made to combat them:

1. The responsibility for co-ordinating and for reviewing the progress on all profit improvement ideas frequently, should be allocated to the appropriate level of management, e.g. Product Manager, or Dept. Manager.

2. Firm targets for review frequency and flexible ones for creativity, and for evaluation and implementation time tables should be listed and evaluated on the above basis.

3. Full or part-time teams should be set up to carry out evaluation and implementation of work.

4. The scale of experiments, the intention to increase the security of the department by introducing changes, and the implications of the number of operatives to be employed need to be discussed with unions and staff.

This revised presentation was then given to Mr.Air, in the 'isolation' of a hotel, as he had suggested. The meeting was successful, as all the aspects of the report and presentation were discussed in detail. This indicated that although personal contact with Mr.Air had been limited, he had taken a good deal of interest in the work itself. During the course of the discussion about the approach and recommendations, Mr.Air raised a number of interesting points, which related directly to the strengths and weaknesses comments made earlier, and also to problems of 'industrial supervision'. The outcome of the meeting is discussed in the last section of the chapter (7.6), but this is preceeded by some general comments on points arising from the meeting.

7.5. Comments and Criticisms from an Industrial Viewpoint.

7.5.1. Originality of ideas - The first point raised by Mr.Air was a feeling of slight disappointment in the ideas that had been generated. He felt that many of them had been expressed in some form or another before the author's arrival, and I had not produced anything startlingly original. (The question of approaches to creative thinking will be discussed in the review chapter at the end of the thesis).

This comment is also related to the 'independent agent' approach. Firstly, it may indicate that constraints to creative thoughts were somehow imposed, possibly the result of developing good working relationships with staff at too early a stage! Secondly, it is a possible indication that the author became too independent of the wishes/aims of the 'client', i.e. had Mr.Air been more involved during the initial stages, then he might have been able to guide hypothesis generation along more 'original lines'.

It must be remembered though, that time and involvement were important, and we were looking to emphasise action. Therefore we tended to look for ideas which could be subjected to a 'Quick and Dirty' evaluation; and thereby provide a reasonable indication of potential savings, rather than produce ideas that would involve a long, detailed programme of research before likely savings were known. One might expect therefore that ideas would not involve drastic changes in the departmental set-up, and the approach, whilst not conductive to orginality, ensured comprehensive coverage of existing potential ideas.

7.5.2. Rejection of ideas for unforeseen 'political' reasons.

This was a weakness of our initial approach that only became apparent at this stage, i.e. at the time when management decisions were to be taken on implementation of ideas. It became apparent that the 'non-financial' or 'political' implications of certain ideas were sufficient to rule out implementation, even if the idea showed a saving.

Thus, the collection of data by an 'independent agent' is not necessarily a straight forward process, as certain 'Cons' may remain undiscovered, especially if they are not of direct importance to those personnel operating in the areas of basic data collection.

e.g. Mr.Air rejected a suggestion that the moulding foremen should be supplied with more technical data about the materials they were using (Idea No.9), so that they could reduce scrap by altering the moulding parameters of the moulding machines. The idea, although showing a small saving, was unacceptable because of the implications of customer liability, and the ultimate degree of safety attached to such a critical component of a braking system. So at this stage customer liability emerged as an important 'Con', which had remained undiscovered partially through the adoption of an independent role.

7.5.2.1. Customer Liability - Implications for Safety Critical Products -

because this emerged as an important factor, a brief description of its implications is given :

In fact shortly after the research began, an investigation into product liability was conducted by the Product Manager. The investigation may well have been prompted by the large amount of publicity which the Ralph Nader Campaign in the U.S.A. was receiving at the time. Indeed the implications of product failure were emphasised by the fact that in the U.S.A. over four million dollars can be awarded in cases of claims for death or severe injury of a V.I.P.

However, it is not only the immediate effects of product failure which are of vital importance. For instance, the costs of a large 'product re-call' campaign, following product failure, can be extremely expensive. For this reason alone, it was estimated that in the unlikely event of an Insurance Company accepting a policy to cover such re-call campaigns, the premiums for the department would be in the region of £50,000 p.a. i.e. prohibitive. So it must be taken that the company has no insurance cover for :

1. Product re-calls.
2. Product guarantees
3. Professional negligence by employees.

Thus the nature of the product dictates that tight control on process and quality must be exercised by the department.

The 'independent agent' is now faced with the problem of whether or not he should be 'aware of the more 'political' 'cons' at the first stage of evaluation. The arguments for and against can be stated simply, but their evaluation is subjective.

Pros: 1. Time and effort would not be wasted on those ideas, which might be eliminated before evaluation began.

Cons : 1. If the estimated saving were sufficiently large, then the 'political climate' might be changes.

2. The imposition of constraints at this early stage might restrict creative thought, and possibly induce a negative approach into evaluation of ideas.i.e. one might begin to over emphasise the 'cons'.

In the author's opinion it is probably better to be unaware of the possible constraints especially when the evaluation to be performed is 'Quick and Dirty', as in such cases the time wasted on 'pointless' evaluations is likely to be small.

7.5.3. The Problems of Industrial Supervision

Earlier in this chapter mention was made of the problems of industrial supervision, highlighted by last minute cancellation of the first presentation. The points raised by Mr.Air concerning originality of ideas and rejection of ideas are also partially related to the problem, as they tended to occur because of lack of communication between supervisor and student.

Mr.Air's approach to supervision during the initial stage of the project was a policy of 'non interference'. He felt that the approach should be that of the 'independent agent', uninfluenced by the views and opinions of higher management, and for this reason the degree of personal communication was limited.

As already suggested this can be a good approach to adopt in the type of situation encountered, allowing a hopefully unbiased appraisal of the situation. However, the initial stage of an I.H.D. project can be difficult for a student with little or no 'indu trial experience'. Guidance on the correct handling or line of approach in some of the more political areas is often of importance. Hence the student can be faced with the dilemma of accepting some of the more awkward obstacles of the independent agent approach, or accepting the somewhat subjective views and opinions of his industrial supervisor and management.

In the author's view, and in the light of the experience of the project work, the independent role, with little control being exercised by the industrial supervisors, is preferable in the early stages. This must be qualified by saying that a realistic control must be kept on the limits of the approach, and the work must be sensibly directed. Hence, as mentioned in earlier chapters, the importance of the academic supervisor in guiding the work during the initial stages. This attitude to industrial supervision did give rise to problems as mentioned earlier in this section.

A second problem in this area is deciding at what level in the management structure the industrial supervisor should be. It appears that the higher one rises in the management hierarchy, the less time one has available for discussion on the progress etc. of this type of I.H.D. work. Certainly, Mr.Air as a manager of a factory containing eight different production departments could only be expected to devote a maximum ½ day per week to the Lockheed Department, and then only a small part of that time to my work. So the amount of direct industrial supervision appears to be inversely related to the position of the supervisor in the management structure.

However, there is a very good reason for "working with the top man" because often he will be responsible for decisions on implementation of actions involving major changes or large capital expenditure. Therefore the process of implementation is likely to be more readily accepted, and more quickly sanctioned if the work is communicated directly, rather than through an intermediary.

So in spite of the fact that "access" to Mr.Air was somewhat limited, and he occassionaly had to cancel meetings at short notice, his position of authority with regard to implementation of any recommendations made him a good choice for supervisor.

Approximately midway through the project, a second or associate industrial supervisor was recruited to deal with day to day problems, whilst Mr.Air maintained his more general supervisory role.

It should be noted that Mr.Air maintained a high degree of interest throughout the project. This was especially evident during supervisors meetings held to discuss various reports, where his constructuve comments and criticisms indicated a comprehensive knowledge of the work done.

7.6. Outcome of meeting/presentation.

Firstly, Mr.Air agreed that the organisational recommendations should be implemented. The question facing us was who to appoint as manager responsible for co-ordinating all profit improvement ideas in the department. There were two obvious candidates for the position, the Lockheed Departmental Manager, and the Product Manager responsible for the North Factory. Both were suitable, but because of his more frequent connections with Mr.Air, the Product Manager, Mr.Lawrie was chosen.

In order to familiarise him with work that had already been done, i.e. the background to his 'appointment', the presentation was repeated for his benefit. It was also suggested that Mr.Lawrie became an associate industrial supervisor as mentioned in the previous section, who would be able to deal with the day to day problems, and also improve my line of communication with Mr.Air.

Secondly, also in line with the recommendations, it was agreed that a full list of possible profit improvement ideas connected with the department, including any ideas from Production Management, Ind.Eng., Engineering, Production Control and Technical Departments, and any other relevant ideas should be listed for co-ordination into a programme of action. The authors task was to compile the list, and to attempt to evaluate potential savings for each project. Then, after elimination of double counting, produce with the Product Manager a detailed programme for implementation.

Chapter 8

Analysis of Departmental Accounting Ratios.

This chapter deals briefly with reasons for performing the analysis of departmental accounting ratios, and comments on the value of this particular exercise and this type of analysis in general.

8.1. Reasons for performing the analysis

There were several reasons for performing the exercise.

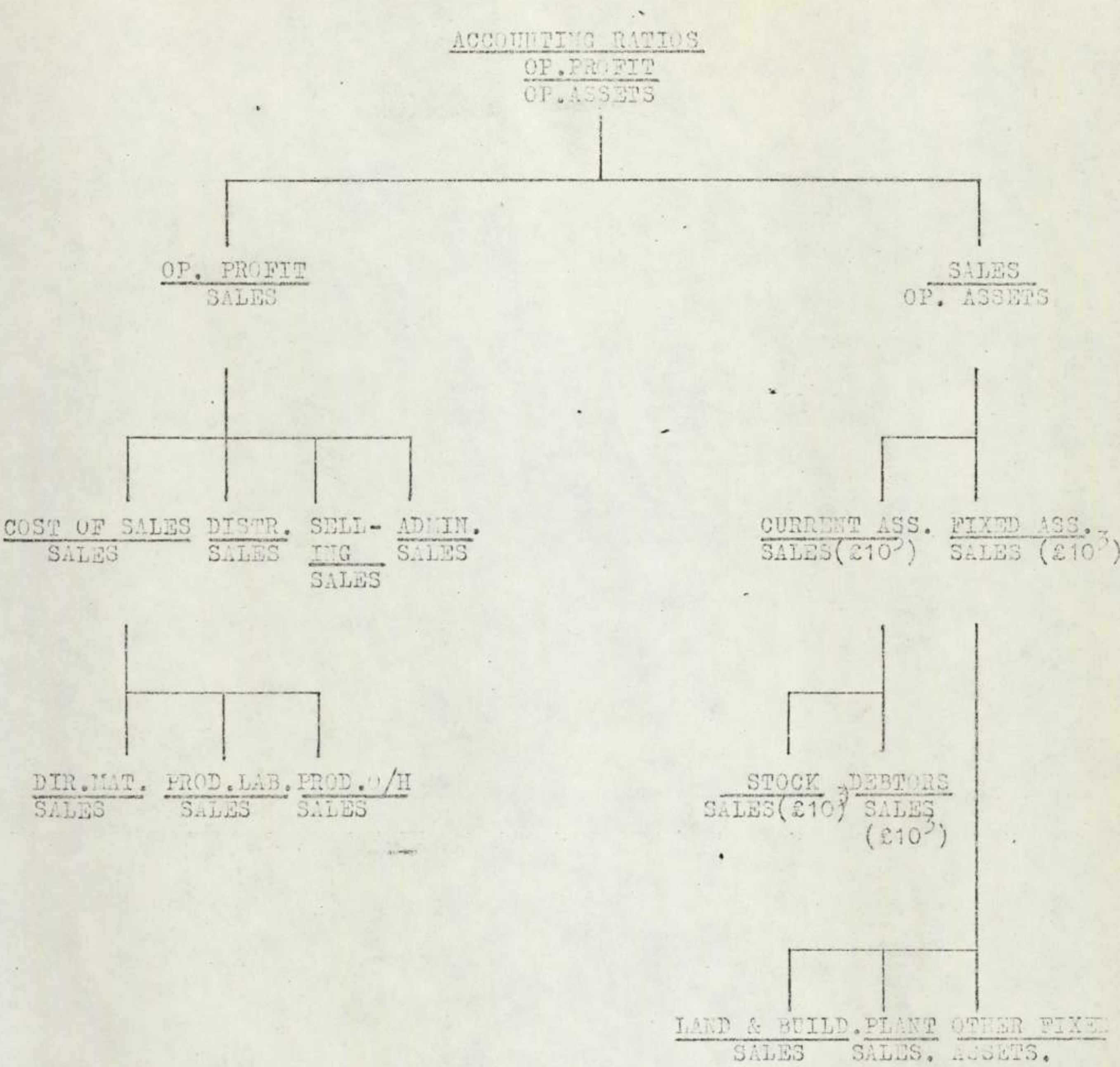
1. The main reason was that this type of analysis might produce further information regarding areas of likely action for cost savings within the department; or at least confirm or contradict indications of the earlier investigation.

2. The analysis could also provide a historical record of financial progress within the department, which could be useful in measuring the overall effect of the projects performed. It might also help identify actual savings arising from the implementation of some of the cost saving ideas, which would otherwise be difficult to determine.

3. As in the Industrial Engineering exercise, if offered an opportunity to establish a good working relationship, in this case with Mr.Lawrie who was enthusiastic about the analysis. It was important that his co-operation be gained since it was intended that we should work together to build a programme of profit improvement ideas. He would begin his role of industrial supervisor with the direct supervision of project work, which indicated to him the degree of importance attached to his position of associate industrial supervisor.

8.2. Analysis of the Lockheed Department Accounting Ratios

The basis of the evaluation of the ratios was a report produced by the centre for Interfirm Comparison on General Rubber Goods factories for 1971. As the division had participated in the



CURRENT RATIO : $\frac{\text{CURRENT ASSETS}}{\text{CURRENT LIABILITIES}}$

ACID TEST RATIO $\frac{\text{CASH + DEBTORS}}{\text{LIABILITIES.}}$

FIGURE 8.1.

compilation of the report a copy was available and was used for comparison.

The report contained a set of interrelated ratios, which took the form of a pyramid as shown in Fig.8.1., the concept being that the causes of poor results of the general indicators of company performance could be traced down through the structure to their root causes.
Ratios identical to those in the report were produced for the department, and a comparison was then made between the quoted median value in the report; the results obtained by Dunlop G.R.G.Division (including the Lockheed Dept.); and the same ratios calculated for the Girling Dept.
As was mentioned in the introduction the Girling Dept. also produced brake seals for the automotive industry, but was operating at profit!
The analysis is as follows : -

Comments on the Lockheed accounting ratios

(The following is an examination of the department's 1971 ratios, starting at the apex of the "pyramid" in Fig. 8.1, and working down through the various combination of ratios to its base). The ratios used for comparison are to be found in Tables 8.1 and 8.2., where the results for the department are tabulated along with the Median Value, and values from firms nos. 10 and 13 from the Interfirm Comparison Report. (Firm 13 being Dunlop G.R.G.Division and firm 10 supplying 60% of its sales to the automotive industry, with a sales turnover in a similar range to Lockheed).

1. Return on Operating Assets.

Ratio 1 relates the achievement of Management to the resources available to them. Since there is a negative value for ratio 1, this indicates that resources have not been used profitably.

2. The result of ratio 1 of - 61.8 is a combination of ratios 2.1. and 2.2. 2.1. is a profit/loss margin on sales of 51.9%. 2.2. is a rate of asset turnover of 1.20 times per year.
So there is a negative profit margin and an asset turnover rate below the median.

TABLE 8.1. ACCOUNTING RATIOS

	MEDIAN VALUE I.C.R.	FIRM NO. 13	FIRM NO. 10	LOCKHEED 1971	LOCKHEED MID 1972	GIRLING 1971	GIRLING MID 1972
1. RETURN ON ASSETS							
1.1. OPERATING PROFIT (LOSS) / OP. ASSETS	8.2	0.3	7.1	-61.8	-50.6	29.2	51.3
2. PROFIT MARGIN AND ASSET TURNOVER							
2.1. OP. PROFIT (LOSS) / TOTAL SALES (%)	4.6	0.2	4.4	-51.9	-47.7	17.8	24.7
2.2. TOTAL SALES / OP. ASSETS	1.36	1.36	1.61	1.20	1.07	1.67	2.07
3. DEPARTMENTAL COSTS AS A % OF SALES							
3.1. TOTAL PROD. COSTS AS A % OF GOODS SOLD	79.9	93.1	78.6	140.5	135.6	71.4	65.9
3.2. DISTRIBUTION COSTS	3.4	2.6	3.5	3.2	3.0	1.5	1.5
3.3 SELLING AND MARKETING COSTS	4.4	3.7	5.1	3.4	3.6	3.1	2.6
3.4 ADMIN. COSTS	4.4	0.4	8.4	4.8	5.2	6.2	5.2
4. PRODUCTION COSTS (AS A % OF SALES)							
4.1 DIRECT MATERIALS	40.9	47.8	40.9	13.8	18.4	6.0	6.5
4.2 PROD. LABOUR COSTS	20.9	18.9	29.2	53.3	46.8	22.0	21.9
4.3 PROD. OVERHEADS	22.3	27.2	9.4	73.4	70.4	46.5	37.5
4.2. PROD. LABOUR COSTS AND PRODUCTIVITY							
4.2.1. COSTS PER. DIRECT OPERATIVE	893	907	1046	1438	1376	1174	1267
4.2.1 VALUE ADDED PER. DIECT OP.	3159	2570	4073	2363	2474	4920	5419
4.2.3. VALUE ADDED PER. PROD. EMPLOYEE	2354	1875	3530	1822	1858	4131	4694
4.2.4. VALUE OF UNDEPRECIATED PLANT PER.DIR.OP.	1733	1975	703	686	863	-	-
4.2.5. NO. OF DIR. OPS. PER SUPERVISOR	9.7	21.9	9.3	25.4	31.7	22.2	26.5
4.2.6. No. OF PROD. EMPS. PER SUPERVISOR	11.6	29.3	10.7	33.0	42.2	24.2	28.0

TABLE 8.2. ACCOUNTING RATIOS

	MEDIAN VALUE I.C.R.	FIRM No. 13	FIRM No. 10	LOCKHEED 1971	LOCKHEED MID.1972	GIRLING 1971	GIRLING MID.1972
4.3. PROD. OVERHEAD (AS A % OF SALES)							
4.3.1. PROD. MANAGEMENT AND CONTROL	2.75	1.58	1.56	9.7	10.5	9.2	7.7
4.3.2. INDIRECT LABOUR	6.83	6.17	1.90	19.0	14.6	8.6	7.4
4.3.3. MAINTENANCE	-	-	-	19.6	12.9	10.0	8.0
4.3.4. DEPRECIATION OF PLANT AND MACHINERY	2.91	2.74	0.68	11.0	12.9	5.6	4.6.
4.3.5. OTHER PRODUCTION OVERHEADS	13.07	16.4	5.24	14.0*	19.5*	13.1*	9.8*
					(Excluding Maintenance Costs - *)		
5. CURRENT AND FIXED ASSETS (per £1,000 of sales)							
5.1. TOTAL ASSETS	736	736	623	834	937	601	483
5.2. CURRENT ASSETS	329	314	353	290	351	307	235
5.3. FIXED ASSETS	419	422	270	544	586	294	249
5.2. CURRENT ASSETS (per £1,000 of sales).							
5.2.1. STOCKS	137	181	94	141	210	94	75
5.2.2. DEBTORS	191	133	259	149	141	214	160
5.3. FIXED ASSETS (per £1,000 of sales)							
5.3.1. FACTORY LAND AND BUILDINGS	236	238	207	144	153	255	219
5.3.2. PLANT AND MACHINERY	184	155	57	250	275		
5.3.3. OTHER FIXED ASSETS	13	29	6	150	153	39	30
5.3.1. LAND AND BUILDINGS							
VALUE OF LAND AND BUILDINGS per.sq.foot.	2.8	2.3	3.8	2.9	2.9	-	-
SALES per.sq.ft.	12.2	9.5	13.5	20.3	18.1	16.0	19.3

3. Departmental Costs (as a % of Sales).

The figures in this section determine the profit/loss margin. In the Lockheed Department the loss margin of 51.9% is a direct result of total production costs running at 140.5%. The other Departmental Costs in this section are at approximately the quoted median value.
This total production cost is almost double the quoted median and Girling values of 79.9% and 71.4% respectively.

4. Production Costs (as a % of sales)

High production costs can be attributed to high production labour, and production overhead costs. These will be examined in detail in this section.

4.1. Direct Material Costs

Although the ratio 4.1. is low compared with the quoted median at 13.8% the Lockheed value is more than double that of Girling.

4.2. Production Labour Costs

The high production labour ratio (4.2) for Lockheed, is one of two major causes of the Departmental loss. The value of 53.3% is almost two and a half times the median and Girling values. Breaking this down further, the value of cost per direct operative (4.2.1) at £1,438 is almost twice the median value and higher than the Girling value.
One interpretation of these facts is that in 1971 Lockheed was 40% overstaffed compared with Girling, and was paying direct operatives 22% more.

1. Taking production labour costs as a % of sales in 1971 the ratio for Lockheed : Girling was 53.3 : 22.0 = 2.42 : 1.
   i.e. Taking Girling value as the mean, Lockheed costs exceed the mean by 142%.
2. Comparing the cost per direct operative in 1971 the ratio of Lockheed : Girling was 1,438 : 1,174 = 1.22 : 1
   i.e. Direct operatives in Lockheed cost 22% more than Girling.
   Therefore Lockheed production labour costs excess above Girling is caused by higher direct operative costs and overstaffing.

Also the value added, per direct operative, and per production employee is only 3/5 of the value achieved by Girling.
Ratio 4.2.4. shows the low degree of capital intensity of the Lockheed Department compared with the median. Unfortunately, results are not available for Girling.
Finally, the level of supervision is well below the quoted median value, but since it is almost equal to that of Girling, it becomes difficult to evaluate.

4.3. Production Overheads.

The result for this ratio for Lockheed is 73.4%, compared with a quoted mean value of 22.3% or 46.5% for Girling. This ratio therefore indicates the second major factor responsible for producing a Departmental loss.
Thus breaking the ratio down further and making a direct comparison between Lockheed and Girling, we see from the table that the following Lockheed ratios :

1. Indirect Labour (4.3.2.)
2. Maintenance (4.3.3.)
3. Depreciation (4.3.4.)

are all approximately double those for Girling.
(Note - the Depreciation figures for Lockheed and Girling cannot be compared with the quoted mean, since they contain extra figures for buildings, fixtures and fittings etc.).
Finally if, as in the Interfirm Comparison Report, Maintenance costs are included in ratio 4.3.5., then other production overheads for Lockheed become almost two and a half times the quoted median.

5. Operating Assets (per £1,000's of Sales).

The Lockheed values for total and fixed assets are higher than the quoted median, while current assets are below the quoted value. Further examination of fixed asset ratios (5.3) shows the value of land and buildings 5.3.1. to be below the median, while plant and machinery and especially other fixed assets 5.3.3. are very much higher than the median.
Both stocks and debtors ratios for current assets compare favourably with the median value.

However, it is to be noted that a reduction in fixed assets, i.e. "other fixed assets" especially, although having a beneficial effect on ratio 1, does not directly affect the profit/loss margin, Hence it would be possible to improve asset turnover, without altering the Departmental profit margin.
Finally, it is of interest that in a fixed asset consideration, it was found that the values of sales, and value added per sq.ft. were higher for Lockheed than for the quoted mean for Girling.

Conclusions

A detailed examination of the ratios resulted in a number of conclusions :-

1. Two ways of effecting a change on the profit/loss margin are :-
1.1. Increase the selling price, to produce an increased sales revenue for the same production costs.
1.2. Reduce total production costs of goods sold.

As can be seen from the appendix it is likely that a combination of both 1.1. and 1.2. will be required to rectify the situation.
A reduction in total production costs could be achieved by reducing the following :-
1.3.1. Direct Material Costs
1.3.2. Direct Labour Costs.
1.3.3. Production overheads especially A) Maintenance Costs.
B) Indirect Labour Costs.

All these reductions should be considered important Departmental objectives.

2. Management of Departmental Assets is not good, and consideration should be given to reducing stocks and "other assets" in the Fixed Assets total.

Appendix (to previous comments)
In line with conclusion 1, the following figures were produced showing the changes required to achieve, what might be considered acceptable values for the major ratios of a profitable Lockheed Dept.

Changes required to achieve acceptable values for Important Accounting Ratios.

1. Operating Profit/Total Sales (%) (2.1).

Assuming a target value for the ratio of +10%, Lockheed value '71 = -51.9%.
Assuming an increase in sales revenue of 25%, and taking Departmental costs in '71.

Then the loss = £147,000
and ratio 2.1. =-18.8%

Hence a target value of +10% is only likely to be reached by a 'reasonable' increase in sales revenue, combined with a in Departmental Costs.
Assuming Departmental fixed costs remain approximately constant.
Then the following combinations are required to achieve the target.

Increase in Sales	+	Decrease in A. Dept. cost	B. Dept. variables
25%		24.3%	33.5%
20%		28.3%	39%
15%		30.2%	41.6%
10%		33.5%	46.2%
5%		36.4%	50%

If Departmental costs remain constant then :-

a) an increase in sales of 48.2% would achieve a 'Break-even' situation.

b) an increase in sales of 62.7% would produce a value of +10% for ratio 2.1.

Hence we can see from the table that large reductions in Departmental variable costs will be required. These reduction could be obtained by a reduction in the following areas :-

	% of Total Variable Costs	
1. Direct Materials	12.8%)	
2. Direct Labour	38.8%)	
3. Indirect Labour	13.5%)	= 93.2% of total variable costs.
4. Maintenance	18.1%)	

Out of those four areas the obvious starting point is labour costs, confirming the conclusions drawn up during the early stages of the research work proper.

2. Total Sales/Operating Assets (2.2)

Median Value = 1.36

Lockheed Value '71 = 1.20

Then taking the Median Value as the target the following figures are required :-

Increase in Sales	Value of Asset to Give the Median
5%	- £484,000 = fall of £39,000
10%	- £507,000 = fall of £16,000
15%	- £531,000 = increase of £8,000
20%	- £554,000 = increase of £31,000
25%	- £575,000 = increase of £52,000

i.e. If the total assets remain at - £523,000, then an increase in Sales revenue of 13% is required to obtain the median value for ratio 2.2.

8.3. Comments on the Value of the Analysis

"The principal value of an analysis of financial statement information is that it suggests questions that need to be answered ; such an analysis rarely provides the answers" - this statement by R.N. Anthony appears to be representative of the "accountants" view of the value of this type of analysis.

The financial situation of the Lockheed Dept. was so bad, that, as might be expected, nearly all ratios were widely different from those found in the I.F.C. Report. The conclusions drawn from the analysis were that variable costs must be reduced, and if possible, selling prices increased.

It is possible that the extreme gravity of the financial situation tended to detract from the value of this type of analysis. That is to say, if the loss had not been so large, then the variation of departmental ratios from the others might not have been so uniformly large, and certain areas for further investigation might have been indicated.

One point of general interest that did arise from the analysis was the fact that the factory/dept. was paying operatives higher than average rates. This may have been attributable to "local conditions" e.g. attracting labour onto a new industrial estate, and keeping rates competitive with other companies on the estate. It tended to stress the importance of the need for effective use of labour.

The work also served a secondary function in that it provided a basis for establishing good communications between the author and the Product Manager.

This in turn meant that he was more prepared to offer full co-operation in establishing organisational recommendations.

An unforseen benefit was the fact that I was given up-to-date information on price increases which were being negotiated by Mr.Lawrie. Since the increases were of the order of 25% overall, this had a marked effect on the departmental financial situation, and it became apparent that the short term target of loss - elimination was attainable.

Chapter 9.

Production and Implementation of a Programme of Proft Improvement Ideas

As had been agreed, the author was to prepare an evaluated programme of all proft improvement projects affecting the department, and aid the manager responsible for the "Project Work" in the control and implementation of the programme.

This chapeter covers the various stages of the programme from initial compilation of ideas, through to the final stages of implementation of individual projects.

9.1. Collection of a Comprehensive List of Potential Projects fot the Lockheed Department.

There were several reasons for compiling as complete a list of projects as possible. First, as an attempt to overcome come of the weaknesses of the "Profit Improvement Opportunity Approach" mentioned in Chapter 7, in the main, double counting of savings, misalloaction of research effort and poor high-level planning. Secondly, it was to provide the manager responsible for co-ordinating the work with a complete picture of the changes he could expect in the department. Furthermore, it provided an opportunity to see how many of the intended projects had been evaluated, and how successful the organisation of the work had been.

The compilation process was simply a matter of discussing the aims of the work with the various managers, e.g. Departmental, Industrial Engineering and Technical managers etc. who then supplied a list of projects they had planned for the department.

In all, a list of 25 projects was produced, including some of which had already been evaluated during the initial period of research. (This list can be found in section 9.2.1.). It is possibly worth noting that the ease with which this operation was performed was related to the "firm-ground" prepared in the earlier stages of research, by talking to and co-operating with some of the managers mentioned above.

9.1.1. Appointment of a new manager responsible for Project Work

At this point, Mr.Lawrie - the manager responsible for co-ordination of project work, left as a result of promotion. It appeared unlikely that a replacement Product Manager would be appointed quickly, and therefore the responsibility for "Project Work" was transferred to the Departmental Manager, Gordon Stockell. As a result of weekly discussions during the early stages of project work, Mr.Stockell was well aware of the aims of the research, and was prepared to co-operate to the full.

The further reasons for his appointment were (i) as Departmental Manager he was the member of the management most affected by the work, and his co-operation was therefore important; (ii) he possessed the personal qualities of a successful motivator of individuals, also likely to be of use in the implementation work.

9.2. Evaluation and Classification of Ideas.

A preliminary evaluation of all the ideas collected was performed, using the same method described in Chapter 6., As might be expected, not all the ideas were to have a direct effect on departmental profitability; indeed, some projects were simply data collection exercises necessary for other ideas, and some more typical technical research projects. However, intially a preliminary evaluation of all ideas was attempted which indicated those ideas likely to fall into the above category.

A detailed evaluation of the ideas can be found in Appendix D, but since the approabh to evaluation was the same as previously described in Chapter 6, all that follows is a list and brief description of the ideas and estimated savings.

9.2.1. Ideas and Estimated Savings.

1. Conversion of Compression Parts to Injection Parts.
2. Determine those hand lathe parts which can be produced on Auto-lathes.
3. Implement recommendations on improving the reliability of Auto-Lathes.

4. Improve old doube-cut lathes.
5. Determine the optimum life of a lathe knife.
6. Design incentive schemes for all lathes.
7. Determine the best method of producing blanks and cord, using a 'collectacool' and batching mechanism.
8. Design an incentive scheme for cord production.
9. Determine those parts whose process specifications do not agree with the present technical drawings, update the specifications and ensure/check that the new specifications are adhered to.
10. Eliminate the stoning and drilling section.
11. Replace liq. CO_2 in the Wheelabrator with liq. N_2.
12. Examine the possibility of compound A.P.R. 1,000 replacing compounds 1701, 1702, and 1707, also the possible development of a compound to replace 1784.
13. Evaluate the minimum acceptable cure times for parts produced on all moulding machines.
14. Determine the stripping time/method for Edgwick parts.
15a. Determine the content of all mould machine downtime, and evaluate possible savings from reducing it.
15b. Reduce moulding machine downtime.
16. Design a payment scheme to coincide with improvements resulting from Projects 13, 14, for press operatives.
17. Design a payment scheme to coincide with changes in finishing operations resulting from Projects 9, 11, (18?).
18. Evaluate the possibility of improving the "clicking" machinery.
19. Evaluate the information gained from Projects 13, 14, and 15, with a view to improving the work scheduling system.
20. Determine the economical batch size.
21. Produce the best bench layouts and inspection work conditions in accordance with Birmingham University recommendations.
22. Investigate the possibilities for regrouping the Finishing Dept. into smaller units.
23. Investigate the possibilities of replacing cardboard packing cases with polythene bags.
24. Design a payment scheme to coincide with improvements resulting from Project. 21.
25. Examine E.P.D.M. compounds and their possible introduction into the Lockheed Department.

9.2.2. Classification of Ideas.

As can be seen from the previous section, not all the ideas were expected to produce savings. In fact, an attempt was made to categorise the ideas.
It appeared that they fell into three main classes :-

A. Feasibility studies (For unevaluated ideas).

B. Research or Data Collection work.

C. Implementation Actions (As indicated after evaluation).

Indeed, in the above order they could be considered the development stages of the project. In the manual produced for the company, (see Appendix G), the three classes were defined as follows :-

A. Feasibility study - to produce a decision as to whether further research is required, or a decision on implementation can be taken on present evidence.

B. Research - to produce results to clarify estimated savings and aid implementation but not make savings.

C. Implementation - to actually produce estimated savings.

Using these definitions the ideas were classified as follows :-

A. Feasibility Projects. Nos. 7, 12, 18.

B. Research Projects. Nos. 2,5,13,14,15a,19,20,22,23,25.

C. Implementation Projects. Nos.1,3,4,6,8,9,10,11,15b,16,17,21,24.

Ideal - as described and evaluated in Chapter 6.

- Estimated Saving - £39,000 p.a.

Ideas 2-6

One of the weaknesses of the initial approach was the possible misallocation/duplication of research effort, and in the example quoted in Chapter 7, it was mentioned that the Ind.Eng.Dept. was examining the possibility of introducing some new hand lathes into the department. In fact, by the time the evaluation was started three new double cut lathes had been purchased. Furthermore, since the first evaluation of the "auto-lathe" idea, an investigation revealed that the output from the machines could be increased by up to 50%, by making minor modifications.

It was agreed that the author should work with a member of the Ind.Eng. Dept. to evaluate all projects affecting the lathe area, i.e. Nos. 2-6 inclusive, and decide upon an optimum set of actions.

One of the major arguments against the original idea of replacing "hand lathes" by "autos" was the limitations to the type and size of parts which could be cut on automatic lathes, hence idea No.2.

The basic intention behind the ideas was to establish minimum labour requirements for the lathe area as a whole, using existing machinery at maximum output under incentive conditions, and then see if replacement of hand lathes by autos was likely to produce savings.

Idea 3 was necessary to achieve the increased output potential of the auto lathes, and idea 4 was to have the same effect on the older double cut lathes in raising their output potential to a level approaching the three new machines. To ensure that full use of this extra potential output was obtained, incentive schemes were to be introduced on all the lathes. In building up a picture of the operations for these schemes the life of a lathe knife was important, hence idea 5.

Estimated Savings : £15,000 p.a.

Ideas 7 and 8

These two ideas concentrated on the "Barwell" area, where the material was preformed into shapes for the moulding machines. As it suggests, idea 7 was an investigation into the methods of producing the preformed material. Idea 8, however, partially covered one idea raised in the initial evaluations, that of improved programming of material production. A simple programming system was to be devised by the Ind. Eng. Dept. for cord production, and its implementation was to be combined with an incentive scheme.

Estimated Savings : £3,000 p.a.

Idea 9

This idea arose from complaints from process control staff that process specifications were not being adhered to, and deviations were only discovered when problems arose. This meant that labour costs not included in the prices were not being recovered. Therefore a list of some 100 parts was produced, covering approximately 85% of schedule to be examined, and where necessary updated.

Idea 10.

"Stoning and Drilling" is a finishing operation for the removal of excess rubber from the inner edges of openings. The production engineer felt that this was an unnecessary operation, which could in the main be eliminated by modification of the moulds and/or removal of the "flash" by freeze trimming in the Wheelabrator.

Estimated Savings : £3,000 p.a.

Idea 11

Dissatisfaction had been expressed by the finishing and inspection foremen about the quality of work produced by the Wheelabrator, and the general efficiency of the machine. In an attempt to improve the situation Air Products Limited had been consulted, and they had recommended replacing the existing refrigerant (liquid CO_2) with liquid nitrogen. They performed a series of trials which indicated savings of approx. £900 p.a. However, a close examination of the report revealed a different typr of "double counting" of savings. The report claimed material cost savings as a result of a fall in the unit cost of material used for batch processed, and a labour saving as a result of a decrease in the batch process time. Then a further material saving was claimed, which was supposedly achieved by not having to use material for batch processing during the saved time. This saving had already been accounted for by the first two evaluations, and as a result, the saving fell by 70%.

Estimated Savings : £140 p.a.

Idea 12

Basically a technical research project concerned with the attempts at compound rationalisation, with the added incentive of eliminating some of the compounds with a short "shelf life".

Ideas 13, 14, 16

The aim of these projects was basically a reduction of Injection Moulding labour, by introducing incentive schemes for one man operating three machines instead of the existing two. Ideas 13, 14, were therefore basically data collection for the preparation of the incentive scheme.

Estimated Savings : £15,000 p.a.

Idea 15

This idea is self-explanatory with 15a being basically data collection and evaluation, and 15b being implementation if 15a indicates savings.

Idea 17

This was to cover any changes that would arise as a result of earlier projects, which might neces itate the introduction of new incentive schemes.

Idea 18

Something of a development project to examine various possibilities for improving the efficiency of the "clicking" machines; i.e. those machines used to remove individual parts from the "mats" containing a number of parts.

Idea 19.

Similar to idea 17, insofar as it was to provide the opportunity to make full use of data gained in early projects, and where changes were likely to affect the work scheduling systems, take corrective action.

Idea 20.

Determine the E.B.Q's is self-explanatory althoughit is worth noting that originally the Ind. Eng. Dept. intended to carry out a number of projects to determine E.B.Q's for various stages of production; these were replaced by idea 20.

Ideas 21 & 24

The University of Birmingham was conducting research work into the inspection area in the sister dept.; Girling. It was hoped that the results of this research would in general be applicable to the Lockheed Dept., and these were implementation ideas designed to make the best use of results.

Estmated Savings - could not be determined until the results were known.

Idea 22.

As evaluated in Chapter 6. However, Mr.Stockell had commented on the accuracy of the data used, he felt that some of the less satisfactory data had been withheld during the experiment. This cast a doubt onto the validity of the savings and therefore further research was required before implementation could be considered.

Idea 23.

Parts were packed for despatch to the customer in small cardboard boxes, and it was felt that material savings could be obtained by using polythene bags instead.

Estimated Savings : £350 p.a.

Idea 25.

Ethylene - Propylene Di Monomer Compounds were a new type of material being examined by the technical department as potential replacements for the existing compounds being used in the department. As such, it was a "pure research" project, but nonetheless it was important that the department sould be aware of progress and the possible implications of the work.

9.3. Construction of a Programme for Project Work.

Having reached a stage where all the ideas had been evaluated or classified, we were ready to form them into a programme or order for action. Before this order/Programme was produced a number of facts had to be established.

1. Interdependence of projects i.e. whether certain projects had to be completed before others could be begun, e.g. projects 2-5 had to be completed before project 6 - the introduction of incentive schemes could commence.

2. The main area/s of work for each project.
3. The availability of departmental personnel to perform the work.

Then in collaboration with Mr.Stockell a project leader/s from the main area/s, was assigned to each project e.g. J.Pitcher, a production engineer took charge of a number of production engineering projects.
The projects were assembled in order of priority, dependent mainly on the magnitude of savings, but also bearing in mind any inter-depending projects and the likely "work-loads" of individual project leaders.
Therefore, at this stage we had a list of projects in order of importance showing :-

1. The project title/description.
2. The estimated savings where applicable.
3. The main area of work of the project.
4. The proposed project leader.

9.4. Presentation of the Programme to the Project Leaders and Assembly of Target Dates.

Once the assembly of the programme was completed a meeting was held of all members of staff within the Department, and staff from other departments involved in the programme. The purpose of the meeting was to indicate the importance of the work in terms of the contribution it could make towards improving the department's financial situation, and to gain the co-operation of the project leaders. This latter point was vitally important, since they were being asked to accept the added responsibility and work on top of their normal "work-load", without financial incentives!

A short presentation was given by the author, explaining the method of approach, a brief description of savings, the purpose of the programme and its likely effects on the financial situation. Also the responsibility of the project leaders was outlined. Basically they were to be responsible for the progress of their projects, ensuring that work was completed on time. They were not necessarily expected to perform all the work themselves, rather they were a form of supervision.

Following this meeting, the author discussed with each project leader the financial savings involved in his project/s, the manner in which the savings had been evaluated and the work involved in the project. He was then asked to set a target time for completion of his project/s. Thus we had a situation where the project leaders were setting their own targets for completion which were then vetted by Mr.Stockell and myself. In general we felt that target times were assessed sensibly, and the only changes made were in cases when people tended to be too optimistic.

Project leaders were also informed of the role Mr.Stockell would take as "Programme Co-ordinator" i.e. his function, once the programme was under way, was to arbitrate on problems, which resulted in conflicts of priorities and could not be settled by the project leaders. Thus where possible, the project leaders were to be given a free hand, however, when there was any doubt they could approach Mr.Stockell for a final decision.

The programme could now be considered complete i.e. savings evaluated where possible, responsibilities assigned and targets for completion fixed.

Fig. 9.1. shows the programme in this final form, and this was then circulated to all the relevant personnel.

9.5. Monitoring the Progress of the Programme

The programme got under way early in December 1972, and a decision to monitor weekly the progress of individual projects was taken for two reasons.

The first was the faily obvious reasons of keeping the manager responsible for the programme informed of the progress and/or problems of individual projects; in case he was required to make decisions on allocations of resources.

The second resons was less obvious as it was to help maintain the interest and momentum of the project leaders in their work. Having recognised the need for progress information there appeared to be two main ways of obtaining it. Either the project leaders could

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT	TARGET DATE
1. Convert Compression parts to Injection Parts where possible, and monitor savings.	£39,000	P.C. - T.Quinn	COMPLETE
2. Determine those hand lathe parts which can be produced on the auto lathes.	)	P. - F.Cave P.E. - P.Smith	26.1.73
3. Implement the recommendations on improving the reliability of auto lathes.	)	P.E. - P.Smith	23.2.73
4. Improve the old double cut lathes	)	P.E. - A.Hughes I.E. - A.Pritchard	26.1.73
5. Determine the optimum life of a lathe knife	) £15,000	P.E. - P.Smith	5.1.73
6. Design incentive schemes for all lathes	)	I.E. - A.Pritchard	23.2.73
7. Determine the best method of producing blanks and cord using a collectacool, and batching mechanism.	) £3,000	P.E. - J.Pitcher	16.2.73
8. Design an incentive schem for cord production		I.E. - D.Day	22.12.72
9. Determine those parts whose process specifications do not agree with the present technical drawings, update the specifications and ensure/check that the new specifications are adhered to.		T. - K.Watts	29.12.72 + random monitoring
10. Eliminate the stoning and drilling section.	£3,000 p.a.	P.E. - J.Pitcher	20.7.73

KEY:

P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL

FIG. 9.1

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT.	TARGET DATE.
11. Replace Liq. CO_2 in the Wheelabrator with Liq.N_2	£140 p.a.	P. - M.Foy	26.1.73
12. Examine the possibility of compound APR.1000 replacing compounds 1701,1702 and 1707, also the possible development of a compound to replace 1784		T. - K.Watts	Prod.Samples January 1973.
13. Evaluate the minimum acceptable cure times for parts produced on all moulding machines.		T. - K.Watts	
14. Determine the stripping time method for Edgwick parts.	See 16	I.E. - J.Styler	17.12.72
15a. Determine the content of all moulding machine downtime, and evaluate the possible savings from reducing it.		P. - M.Foy E. - A.Glease	26.1.73
15b. Reduce moulding machine downtime			2.3.73
16. Design a payment scheme to conincide with improvements resulting from projects 13,14 for press operatives.	£15.000	I.E. - J.Styler	2.3.73
17. Design a payment scheme to conincide with changes in finishing operations resulting from Projects 9, 12, (18?).		I.E. - D.Day	
18. Evaluate the possibility of improving the 'Clicking' machinery.		P.E. - A.Hughes	26.1.73
19. Evaluate the information gained from Projects 13, 14, and 15 with a view to improving the work scheduling system.		P.C. - T.Quinn	20.7.73

KEY :

P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL

FIG. 9.1

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT	TARGET DATE
20. Determine the economical batch size		P.C. - T.Quinn	2.3.73
21. Produce the best bench layouts and inspection work conditions in accordance with Birmingham University recommendations.	Awaiting report	I.E. - A.Pritchard	Awaiting Report
22. Investigate the possibilities for regrouping the Department into smaller units.	£27,000 p.a.	J.R.Bainbridge	20.7.73
23. Investigate the possibilities of replacing cardboard packing cases with polythene bags.	£350 p.a.	P. - G.Stockell	29.6.73
24. Design a payment scheme to coincide with improvements resulting from Project 21.	Awaiting Report.	I.E. - A.Pritchard	Awaiting Report
25. Examine E.P.D.M. compounds and their possible introduction into the Lockheed Department.	?	T. - K.Watts	1974

KEY:

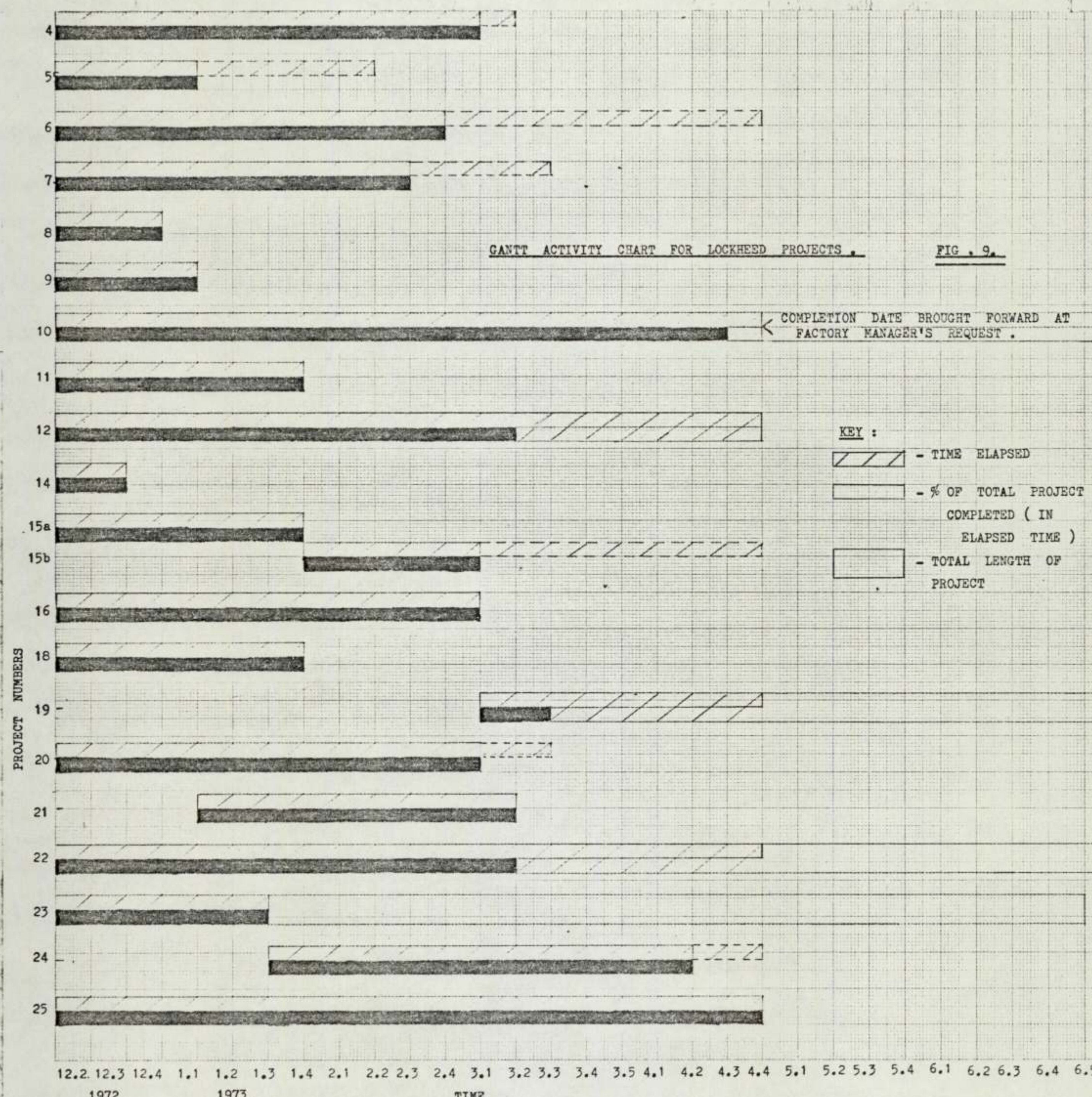
P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL

FIG. 9.1

report weekly, either verbally or in a written report, or the information could be collected from them. It was felt that the first alternative might have a dampening effect on the initial enthusiasm, by increasing an already heavy work-load. However, if the author was to visit each leader once a week and discuss progress and problems, then it might help relieve the burden, and help keep the work in perspective and the targets in mind.

The monitoring was done by means of a simple Gantt activity chart, which showed the target date for completion, the estimated length of the project and the % completion at any given time of individual projects.

The chart (Fig.9.2) was updated weekly by the author, after discussing the progress of the individual projects with the respective leaders, and the chart was kept in the departmental manager's office for Mr.Stockell's reference.



GANTT ACTIVITY CHART FOR LOCKHEED PROJECTS . FIG . 9.

Chapter 10

Evaluation of the Results of the Programme

For the duration of the programme the author's role was largely that of "progress monitor" combined with participation in a number of teams, especially the "lathe projects"team. Once the programme neared completion, the emphasis of research changed to that of data collection for analysis of the effect of the programme.

It would appear that all too often in an industrial environment the results of such work go unevaluated. From a company standpoint it can be argued that emphasis must be placed on the present and future and its often limited resources should be directed along these more productive channels. However, in a company such as Dunlop, where the approach to management and control is said to emanate from a Management Plan, an individual manager is, to a certain extent, judged by his ability to meet the targets of this Plan. The accounting system is often such that it will conceal many underlying changes, which have taken place and that reflect the quality of management. Therefore an analysis of the effects of individual actions can provide :-

1. A check that predictions of actions were correct, which in turn provides useful data for future predictions.
2. A more detailed/accurate picture of the effectiveness of management.
3. Historical data which may be of use in future Management Plans.

In the author's case it was important to analyse the results to help indicate any flaws in the method of evaluation, and check the validity of the "hypothesis".

This chapter and the next cover an analysis of data on two "levels". Firstly, the savings made from individual projects, and secondly, the contribution made by the programme as a whole in relation to other changes that had taken place since the work began.

10.1. Evaluation of the Results of Individual Projects from the Profit Improvement Programme

10.1.1. Summary of Results (April 1973).

The programme consisted of 25 projects :

Feasibility Type	:	3
Research Type	:	10
Implementation Type	:	15
Completed	:	12
Continuing	:	3
Awaiting further decisions/information	:	3
Rejected after further research	:	2
Failed	:	2

Total Savings from the Programme	:	£99,000 p.a.
Total Predicted Savings from the Programme.	:	£103,000 p.a.

Dealing with the above list in reverse order :

Projects 15 and 20 failed completely.

- No.20 because the amount of work involved and limited resources to process data.
- No.15 because of a clash of personalities between the two project leaders.

Projects 22 and 23 were rejected after further research.

- No.22 as a result of changes in the finishing labour and scrap rates, potential savings were vastly reduced to an insignificant level.
- No.23 because it was found that the A.P.Ltd. factory had a conveyor system which accepted cardboard boxes, but not polythene bags. The idea had therefore to be rejected.

Projects 7, 12, and 18 were basically feasibility studies, which on completion had produced data from which evaluations could be made.

Indeed, in No.12, the attempted introduction of a new replacement compound, samples had been sent to A.P.Ltd, and a decision was required from them before proceeding.

Projects 21, 24, and 25 were continuing.

- Nos. 21, and 24 were the research projects conducted by Birmingham University.
- No.25 was the long term materials research project.

The remaining 15 projects were completed and what follows is the analysis of the effects of the 10 completed implementation projects, and five associated research projects.

10.2. Analysis of the Results of Individual Projects.

Idea 1. Conversion of Compression to Injection Parts where possible

Estimated Savings : £39,000 p.a.
Actual Savings : £58,450 p.a.

It was orginally anticipated that 16 parts were suitable for conversion. The main doubts were whether Automotive Products Ltd. would pay for replacement moulds. In fact, twelve parts were converted and the new injection moulds supplied by A.P.Ltd. As a result of this purchase of these new moulds and changes in business, the schedules changed. The following table shows the twelve part numbers, the schedules after conversion, and the total required output to achieve the schedules by the two types of moulding.

Part No.	Monthly Schedule	Compression Moulding		Injection Moulding	
		% Total Scrap on Good.	Total Monthly Output.	% Total Scrap on Good.	Total Monthly Output.
3812-430	35,000	75	61,200	23	43,000
3812-733	6,000	47	8,820	56	9,360
3813-711	2,500	33	3,325	49	3,725
3813-713	20,000	40	28,000	38	27,600
3815-737	300	36	408	7	321
3815-742	15,000	46	21,900	18	17,700
3817-715	16,000	73	276,800	39	22,240
3873-422	26,000	111	54,860	22	31,720
3875-429	18,000	86	33,600	30	22,900
27867	18,000	59	28,620	15	20,700
33427	66,000	55	100 ,000	16	81,300
98796	1,500	-	Figures not	available	-
Total Parts	228,000		368,500		280,620

The good quantity required	=	228,000 parts per month.
Total Injection quantity required.	=	280,620 parts per month.
Total Compression quantity required.	=	368,500 parts per month.

Now using the figures used in the original evaluation of savings (see Appendix A).

Then material savings = (Total No. of Compression parts P.A. x average material costs) - (Total No. of Injection parts P.A. x average material costs)

= 368,500 x 12 x £0.0169 - 280,600 x 12 x £0.00121

= £7,500 - £4,150

= £3,350 p.a.

Then labour savings = (Total number of Compression parts P.A. x average labour cost)

- (Total No. of Injection parts P.A. x average labour costs)

= 368,500 x 12 x £0.0118 - 280,620 x 12 x £0.00546

= £52,200 - £18,400 = £33,800 p.a.

As a check against the labour saving an analysis of the reduction of compression labour was made. It was assumed that the labour saving was basically a saving in moulding labour, since the unit cost of finishing and inspection labour would remain approximately constant.

Comp. Moulding Labour :

Before conversion	After conversion
39 Male Ops.	21 Male Ops.

Saving =	9 males receiving	-	£13,800 p.a.
	9 males receiving	-	£13,500 p.a.
	+ Nat.Ins.Contributions	-	£ 1,800 p.a.
	Total Moulding Labour Saving.		£29,100 p.a.

These moulding labour savings were a direct result of the conversions, which resulted in the closure of the 6 machines per shift. Although there is a difference of £33,800 p.a. - £29,100 = £4,700 p.a. between the calculated labour saving and the moulding labour saving, this could probably be accounted for by a fall in finishing and inspection labour caused by the difference in the total outputs required to produce the schedule. This is more difficult to determine because of the other changes in these areas.

Similarly maintenance cost savings

= (Total No. of Comp. parts P.A. x Av. cost of maintenance per part)

- (Total No. of Inj. parts P.A. x Av. cost of maintenance per part).

= 368,500 x 12 x £0.00535 - 280,620 x 12 x £0.00070

= £23,660 - £2,360

= £21,300 p.a.

Of this total £14,000 p.a. was saved by the closure of the "Iddons", a set of compression machines, which were particularly costly to maintain, (this figure was obtained from an Engineer Report). The remaining £7,300 cannot be so readily identified, however, since the departmental maintenance costs dropped by approximately £60,000 p.a. in the same period it is reasonable to assume that this remaining portion was also saved.

Thus we have a total saving of £3,350 + £33,800 + £21,300 p.a. = £58,450 p.a., the bulk of which can be directly accounted for.

It is worth noting that this figure is considerably in excess of the original estimate of - £39,100 p.a., the reason for this being that the increase in schedule requirements by approximately 42%. This would raise the initial estimate to - £56,100 p.a. which is much nearer the actual total.

Ideas 2-6 The Lathe Projects   Estimated Saving : £15,000 p.a.
Actual Saving : £16,300 p.a.

Projects included :

- Determination of hand lathe parts suitable for auto lathes.
- Determination of optimum life of a lathe knife.
- Implementation of recommendations for improving auto lathes.
- Improvement of the older double cut lathes.
- Implementation of incentive schemes.

A. Dealing firstly with the auto lathe section we had three projects affecting the area :

1. Investigation for new parts.
2. Improvement of the output potential.
3. Incentive schemes.

An analysis of the workings of the section revealed the following :

	Before Projects	After Projects
Av. output per day from the section	69,400 parts	106,000 parts.
Number of operators	3 men	2 men
Number of machines worker per operator	3	4
Av.wages paid to the section	£6,300 p.a.	£5,200 p.a.

∴ Total actual saving on Auto Lathe Labour
= £1,100 p.a.

We now have a 53% increase in output from the section (i.e. 36,400 parts per day). This was equivalent to the output of approximately 4 hand lathes under new incentive conditions. In fact the total labour force did not fall by 4 operatives as this increased output represented an increase in the schedule requirements. It merely meant that a further four operatives were not added to the existing complement to cope with the additional work.

∴ Saving of Hand Lathe Labour = £5,400 p.a.

Spin off saving

Due to the increased output from the section, the female operative sorting uncut or misfeed parts was unable to cope with the work load. To solve this problem automatic sorting machines were introduced to perform the work.

This resulted in a reduction of the section labour force by 1 female - Saving £1,200 p.a. (With a capital costs of machinery = £440).

Total Savings from "Auto" Projects = £1,100 + £5,400 + £1,200
= £7,700 p.a.

The total capital cost of these projects was :

1. Cost of improvements to "Autos" - £113
2. Cost of automatic sorting machines - £440

Total £553

B. Hand Lathe Projects

Projects affecting the area :

1. Improvement of the old double cut lathes.
2. Design of incentive schemes.
3. Determination of the optimum life of lathe knives.

An analysis of the section revealed the following :

	Before Projects		After Projects.
Number of lathes (1 female operator per lathe).	6 - Doublè cut -		6
	12 - Single cut -		7
	1 - Back stop -		1
Output per day from the section	98,000 parts		98,000 parts
Operators wages	£24,700 p.a.		£18,200 p.a.

Total actual saving in hand lathe labour
= £6,500 p.a.

However, in this case, it is possible to separate out the effect of improving the old double cut lathes.
Since the increase in output rose from approximately 5,500 parts per day to approximately 7,200 parts per day

∴ The increase in output from the 3 old double cut lathes
= 5,100 approx. or the output from one lathe.

This is equivalent to a saving of £1,300 pa.

However, it is included in the saving above.

As a result of the reduction in the number of hand lathe operators and also drilling operators (from a later project), the number of male 'leading hands' responsible for "setting" machinery in the finishing area, was reduced by 1.

This represented a saving of £2,100 p.a.

Thus the total savings from the hand lathe projects = £8,600 p.a.

The total capital cost of the project was :

1. Cost of improving double cut machines	-	£265
2. Cost of other machinery required for incentive schemes.	-	£640
	Total	£1,005

Idea 8 - Design of Incentive Scheme for Cord Production

Estimated Saving : £3,000 p.a.
Actual Saving : £2,300 p.a.

The original estimated saving was based on an expectation that the number of two-man shifts worked on the machine could be reduced from 3 - eight hour shifts to 2 - 10 hour shifts after the introduction of an incentive scheme. In fact, because of Union resistance to the removal of one shift, this was not achieved. However, the incentive scheme did reduce the need for overtime to be worked, and, by the rating of particular "jobs", reduced the average earnings of the men as can be seen below :

	Before	After
Av. man hours worked on the Barwell section.	271 hrs. per week	241 hrs. per week.
Av. wages paid to the 6 men in the section.	£303 per week	£255 per week.
Av. wages paid per hour per man.	£1.12p.	£1.06p.

Total Savings in cost of Barwell labour = £48 per week.
= £2,300 p.a. (For a year containing 48 working weeks).

Idea 9 - Update specifications - Estimated Saving - Unevaluated.
- Actual Saving : £1,350 p.a.

The project covered 100 part numbers which represented 80% - 85% of the total output of the department. The production specifications for these parts were compared with the actual operations performed on the parts to discover deviations from the specification.
The most important discovery was that part number 39994 was being stoned (a finishing operation for removal of "flash"), and this was not required as the flash now came with accepted limits.

Savings

- The customers' requirements were 55,000 good parts per month.
- The scrap rate was 27% scrap on good.
- This meant that a total of 70,000 parts per month were being stoned. From Ind.Eng. rates the time required to "stone" 100 parts was 14 minutes.

∴ The total time taken to stone the schedule required was 163 hours per month.

≡ 1 operator working full time.

∴ Saving was 1 Drilling Operator = £1,350 p.a.

(Total capital expenditure = Nil)

Idea 10 - Eliminate the Stoning and Drilling Section

Estimated Saving : £3,000 p.a.

Actual Gross Saving. : £4,400 pa.

From the outset of this project it had not been anticipated that the section could be completely eliminated, it was mainly an attempt to reduce it to a minimum size.

As can be seen below the exercise resulted in a two thirds reduction of the labour force.

Savings :	Before	After
Number of Operators	6	2
Total wages paid	£8,500 p.a.	£2,700 p.a.

Total Gross Saving = £5,800 p.a. (i.e. 4 ops).

However, a saving of one operator was made as a result of the previous project (Idea 9). Therefore if we are to eliminate "double counting" of saving, the actual gross saving must now be reduced to 3 operators. i.e. £4,400 p.a.

The total capital expenditure on the project was approximately £1,800. This was the cost of modifications to various moulds to eliminate the need for the operation. So in the first year the project would have a total NET saving of £4,400 - £1,800 = £2,600.

Idea 11 Replace the Liq.CO_2 refrigerant in the Wheelabrator with Liq.N_2

Estimated Saving : £140 p.a.

Actual Saving : £2,000 p.a.

In this case the vast difference in savings can be attributed to three factors. The first two were a result of inaccurate measurements by the consultants called in to estimate savings. The length of time required to process a batch was approximately 4 minutes, instead of $5\frac{1}{2}$ minutes, and this reduced the cost of liquid nitrogen refrigerant from an estimated 21.92p. per batch to 18.42p. per batch (see results below). Thirdly the number of batches processed per month increased.

Results.

1. Average cost of refrigerant per batch
   By monitoring consumption over a week, and analysing the operator work sheets for the same period it was found that 4,389 kgs. of Liq.N_2 were used to process 588 batches, in an estimated 40 hrs. operating time.
   ∴ The quantity of Liq.N_2 used per batch
   = 7.46 kg. = 16.45 lbs.
   Price of Liq.N_2 = 1.12p. per lb.
   Price of Liq.N_2 per batch = 16.45 x 1.12 = 18.42p.

2. Average process time per batch
   Analysis of the batch processing times produced by the Technical department, after trials on the converted machine, indicated an average process time = 4 mins. or 15 batches per hour. (This compares with $\frac{588}{40}$ = 14.7 batches per hour from the above survey).

3. The number of batches processed per month rose to ~2,700 as a result of increased schedules, and taking on extra work from other departments.

These results led to the following analysis of savings :

1. Total saving in refrigerant costs = 2,700 x 22.82p. - 2,700 x 18.42p. (see results above)
   = £616 - £496 per month
   = <u>£120 per month.</u>

2. Also the expected savings of materials used during the de-frost operation were obtained i.e. 1 bag used instead of 2 "Sorboil"
   = <u>£2.50 per month</u>

3. Labour savings were calculated in three areas :

A. Operator time

Time taken to process 2,700 batches using Liq.CO_2

= 2,700 x $6\frac{1}{4}$ mins. = 290 hrs. per month

Time taken to process 2,700 batches using Liq.N_2

= 2,700 x 4 mins. = 180 hrs. per month

i.e. A saving of 110 hrs. per month.

B. Defrost time

As the new refrigerant had reduced condensation, the monthly defrost operation was reduced from 6 hrs. to 4 hrs.

A saving of 2 hrs. per month.

∴ A Total Labour Saving = 124 hrs.

Assuming a payment rate of approximately £0.77 per hr. the above 124 hrs. per month is equivalent to a wages saving of 124 x £0.77 = £95 per month.

∴ Total monthly savings = £120 + £2.50 + £95

= £217.50p.

However, there was a monthly rental to pay on the Liq.N_2 storage tank of £50, whilst the Liq.CO_2 tank was owned by Dunlop.

∴ Total Net Monthly Savings = £167.50p. per month

= £2,000 p.a.

(The capital expenditure on the installation of the Liq.N_2 tank was £363).

Idea 16 Design an Incentive Scheme for Edgwicks.

Estimated Saving : £15,000 p.a.

Actual Saving : £14,400 p.a.

This also covered research projects 13 and 14 which provided the data required for the incentive scheme. The scheme included the introduction of one man operating three machines instead of the normal two. The savings were relatively simple to evaluate as shown below :

Savings :

	Before	After
No. of direct operatives	30 males	24 males
Average hours worked by the section.	1,281 hrs.	864 hrs.
Average wages paid to the section	£1,171	£872

Savings = £300 per week

= £14,400 p.a. (for 48 working weeks p.a.)

(The total capital expenditure on the section involved in moving the machines to allow 1 man to operate three machines was carefully documented by the Engineering Dept.= £3,000).

Idea 19 Design Payment Schemes to Coincide with Changes in the Finishing Area.

The most important changes were in the lathe sections, but these schemes have already been evaluated.

An incentive scheme was introduced on the Roller Trimming Section. It resulted in increased output from the section, but since this increased output was required the extra cost was not offset by a labour reduction. Savings were therefore negligible.

10.3. Comments on the Results

1. In all cases where savings were predicted, they were obtained on implementation. Indicating, as might be expected, that the predictions of the approach on a general level were correct, and the approach was a valid one.

2. The degree of accuracy of the approach leaves something to be desired, although it is worth noting that as a general rule those savings that differed widely from the estimates were affected by changes which would have been difficult to predict. e.g. the changes in schedules of "compression parts" after conversion to "injection parts". Also, the approach does not claim a high degree of sophistication likely to produce very accurate results. Indeed, the author would maintain that in the type of situation encountered during the first 15 months of research, the approach produced sufficiently accurate data on which decisions could be taken with a satisfactory degree of confidence in the outcome. Furthermore, the approach would appear preferable to the more undisciplined attitude adopted by personnel within the Company at present.

3. The total savings of the programme appear to have made a significant impact on the financial situation of the department. However, there would still appear to be a long way to go before a wholly satisfactory situation is reached.

An examination of the accounts in fact showed that the department was likely to make a small profit in 1973. Therefore, to place the contribution of the programme into some sort of perspective, an analysis of all the causes of improvement or change was performed.

Chapter 11

A Retrospective Analysis of the Reasons for Changes in the Lockheed Department Financial Situation.

The departmental profit/loss accounts for the first months of 1973 indicated that the department was nearing a "break-even" situation. This dramatic improvement could only in part be accounted for by the profit improvement programme. Therefore an investigation was performed to determine the other causes of improvement,
In fact, the starting point of the analysis was the departmental accounts of 1971, and a projected account for 1973. The object was to discover, on a general level, the reasons for change in the Sales Revenue and Total Costs, which in turn reflected the change in profitability. During the analysis the following were considered as possible reasons for the change :-

- Volume change
- Product mix change
- Prices
- Materials cost change
- Projects
- Organisational change.

This chapter covers the investigation of the effects of the above factors.

11.1 The Lockheed Department 1971-1973.

The following two tables indicate the general picture of change presented by the information most readily available to the department.

Table 11.1 General Figures

	1971	1972	1973
Total Good Parts Sold	37.9 million	32.8 million	38.5 million
Sales Revenue (inc.Misc. Income).	£627,000	£678,000	£895,000
Total Costs	£943,000	£813,500	£866,000
Profit/Loss	(£316,000)	(£134,700)	£ 29,000
Total number of Employees	306	248	210

Table 11.2 Departmental Accounts

	1971 (£,000's)	1972 (£,000's)	1973 (£,000's)
Labour Costs (inc.maintenance+fringe benefits).	460	378	402
Material Costs	86	85	92
Maintenance Materials	40	25	26
Power Costs	23	26	27
Direct Cost Total	609	514	547
Fixed Costs	334	300	319
Total Costs	943	814	866
Total Revenue	627	679	895
Profit/Loss	(316)	(135)	29

Comments :

1. From the above tables the change in profitability between 1971 and 1973 is equivalent to an increase in profit of £345,000 p.a.

2. This increase was a result of :

   i. An increase in Sales Revenue of £268,000 p.a.

   ii. A decrease in Total Costs of £77,000 p.a.

and in fact the next stage of the investigation was to examine these two areas, in an attempt to determine which factors mentioned in the introduction caused the changes.

11.2. Changes in Sales Revenue

1971 - Sales Revenue	£579,000	1973 - Sales Revenue	£860,000+
Misc.Income	£48,000	Misc.Income	£35,000
Total Income	£627,000	Total Income	£895,000

Table 11.3

(+ 1973 - Sales Revenue calculated from estimated deliveries and 1973 prices).

Difference in Total Income = £268,000

However, we can see that in fact Misc.Income had fallen by £13,000 p.a. and that Sales Revenue had increased by £281,000 p.a. It was this increase that it was hoped to explain by analysis.

Of the two areas mentioned above, Sales Revenue was the simpler to analyse, since there are basically only three factors that affect the income from sales :

A. Quantities of parts sold.

B. Product Mix

C. Price of Parts.

These factors are now examined in turn.

11.2.1. Effect of Changes in Volume

As we can see from Table 11.1 the change in the number of good parts sold from 37.9 million parts in 1971 to an estimated 38.5 million parts in 1973 can be considered negligible. Thus it was considered there was no volume effect on sales revenue or, in fact, on variable costs.

11.2.2. Effects of Changes in Production Mix.

The analysis was performed by examining the average monthly schedules for 1971 and 1973, and evaluating the sales value of each schedule at 1971 prices. This data can be found in Appendix E, which is the basis of the table below.

	1971	1973
Monthly Schedule (parts)	2.86×10^6	3.24×10^6
Value of Schedule at 1971 prices	£44,900	£57,500
Average Price of Parts	£1.57 per 100	£1.79 per 100

Table 11.4

It was in fact possible to take the analysis a stage further from the data and subdivide the schedules into "Seals" and "Boots", the two basic types of part produced in the department.

	1971	1973
Seals as a % of the monthly schedule	68.6% ≡ 1.96×10^6 parts	70.0% ≡ 2.27×10^6 parts
Value of "Seals" schedule at 1971 prices	£23,800	£35,300
Average price of seals	£1.21 per 100	£1.56 per 100
Boots as a % of the monthly schedule	31.4% ≡ 0.9×10^6 parts	30.0% ≡ 0.95×10^6 parts
Value of Boots schedule at 1971 prices	£21,100	£22,200
Average price of Boots	£2.35 per 100	£2.34 per 100

Table 11.5

Therefore it appeared that a change in the product mix of seals resulted in an increase of sales revenue of (£35,300 - £23,800) x 12 = £138,000 p.a.

However, an adjustment had to be made to account for the difference in monthly schedules. As can be seen from Table 11.1 the total number of parts sold was 37.9 million, which in turn meant that an extra 3.6 million parts, (37.9m - (2.86m x 12)) were sold, over and above the schedule. The value of these parts was £579,000 - (£44,900 x 12) = £40,200 p.a.

From Table 11.5 we see that an extra $0.05 \times 10^6 \times 12$ "boots" were sold for £1,100 x 12 = £13,200 p.a. and therefore the remaining 3 million "seals" produced a revenue of £27,000.

Thus the change in product mix of "seals" resulted in a net increase in revenue of £138,000 - £27,000 = <u>£111,000 p.a.</u>

11.2.3. Effects of Change in Prices.

Table 11.6 below indicates that the average selling price of 100 parts had risen by approximately 46% between 1971 and 1973. This increase was in part due to the change in product mix, which resulted in an increase in price from £1.527 to £1.79. The further increase in price was then attributable to the negotiated price increases, in Sept. - Oct. 1972 when a blanket increase of 25% on 1971 prices was obtained.

	1971	1972	1973
Number of parts sold	37.92×10^6	32.81×10^6	38.5×10^6
Sales Revenue	£579,000	£640,000	£860,000
Average Selling Price	£1.527 per 100	£1,951 per 100	£2.236 per 100

Table 11.6

The effect of the price increase was calculated by taking 25% of the 1973 monthly schedule revenue, evaluated at 1971 prices.

i.e. The effect of price increases on sales revenue

$$= +£57,500 \times 12 \times \frac{25}{100} = \underline{+£172,500 \text{ p.a.}}$$

However, a monthly schedule of 3.24×10^6 parts was equivalent to a year's schedule of 38.9×10^6, which was 0.4×10^6 parts or 1% above delivery.

Therefore the above figure was reduced by approximately 1% to

= £171,000 p.a.

11.2.4. Summary

It was possible to identify three causes for the change in the Total Income (Table 3) :

1.	A decrease in Misc. Income	-	£13,000 p.a.
2.	An increase in revenue due to a change in product mix.	+	£111,000 p.a.
3.	An increase in revenue due to a change in prices.	+	£171,000 p.a.
	Net Effect	+	£269,000 p.a.

This compares with the 'actual' change of + £268,000 p.a.

- It is worth noting that there is another effect that can be considered when analysing causes of change in revenue, and this is the combined effect of changes in price and volume of individual parts. This was not considered at the time, and in fact the effect was "absorbed" by the price increase effect. However, a discussion of this effect and its evaluation can be found in the "Gross Retrospective Analysis" manual in Appendix H.

11.3. Changes in Total Costs

The fall in total costs of £77,000 p.a. was considerably more difficult to analysie for two reasons :

A. There were many more possible causes of change than the three controlling sales revenue.

B. The total costs for 1973 were estimates based on the departmental profit/loss account for the first six months of the year, rather than actual figures.

The first stage of analysis was a breakdown of the total costs, in slightly more detail than shown in Table 11.1.

TOTAL DEPARTMENTAL COSTS	'71 (£,000's)	'73 (£,000's)
Labour Costs	366	328
Nat.Ins. Holiday Pay etc.	55	42
Raw Materials costs	86	92
Maintenance labour costs	81	41
Maintenance material costs	40	26
Power Costs	23	27
'Other' costs	24	22
Total Variable Costs	675	578
Fixed Costs	268	288
Total Costs	943	866

Table 11.7

The composition of figures in the Table differs slightly from those in Table 11.1 since in this case "Other Costs" and a portion of maintenance costs are included in the variable section. The maintenance costs were in fact the portion of the Maintenance Department "Fixed Costs" that were charged to the Lockheed Department as variable costs. These had been separated out in the earlier table at the request of Mr.Air.

The analysis was then composed of two sections :

(i) Investigation into change in variable costs.

(ii) Change in Fixed Costs.

11.3.1. Change in Variable Costs

From Table 11.7 we see that the Total Variable Costs fell by £97,000 p.a. between 1971 and 1973. Now the evaluation of the effects of the Profit Improvement Programme (P.I.P.) had already indicated savings of £99,000 p.a., therefore the temptation might have been to assume that the fall had been accounted for. However, there were other factors whose net effect was almost zero which were considered.

A somewhat 'rough and ready' analysis was performed to look at some of these major 'hidden' factors in an attempt to define at least the orders of magnitude of the effects. A detailed analysis was not performed for a number of reasons, namely :

1. Data that was readily available was not suitable for anything more than a rough examination.
2. Time for research was limited and it was felt could be better utilised to perform other work.
3. The aim of the exercise was basically one of placing the P.I.P. into perspective, rather than to provide a detailed evaluation of all changes.

For these reasons the investigation was in the main limited to evaluating the effects of the following :

A. Wage Increases.
B. Management actions to reduce maintenance costs.
C. Reduction in scrap levels.

11.3.1.1. Effects of Wage Increases

Using the data in Table 11.1., it was found that the average earnings per operator had risen from £1,194 p.a. to £1,570 p.a. In fact the majority of this increase was attributable to negotiated wage rises. During the two year period there were two pay awards made to the operators.

1. In July 1972 an increase of approximately 10p. per hour per operator was negotiated.

   This would have increased the wage bill by

   $$306 \times £4 \text{ per week} \times 52 = £63,600 \text{ p.a.}$$

   if no action had been taken to reduce the labour force.

2. In July 1973 an increase of £1 per hour + 4% was awarded, and this would have increased labour costs by a further £33,700 p.a. in a full year, or £17,000 p.a. in the remaining six months of 1973 if no action had been taken.
   i.e. The total effect of wage increases would have been to increase labour cost by £81,000 p.a. However as we are aware, labour cost reduction actions were taken in the P.I.P.

11.3.1.2. Effects of Actions on Maintenance Costs

Maintenance costs fell for two reasons :

1. An estimated £22,000 (approx.) was saved as a result of the changeovers from Compression to Injection moulding.
2. During 1971, costs had reached £121,000 p.a. and actions had been taken by management to reduce these costs. These had involved more use of planned and preventive maintenance, and attempts to exercise a tighter control on request of engineering services. As can be seen from Table 11.7. costs fell to approximately £67,000 p.a. i.e. a gross saving of £54,000 p.a. However, since £22,000 has already been accounted for in project savings, a net saving of £32,000 p.a. remained.

11.3.1.3. Effects of a fall in Scrap Levels.

Departmental inspection reports indicated that the level of scrap (on good parts) had fallen from 44% in 1971 to 28% in 1973. Therefore cost of scrap data similar to that described in Chap.5. was produced for 1973 labour and materials costs. A summary of this is shown below :

Labour Costs of Scrap	1971	1973
Injection Scrap		
Labour cost of moulding scrap	£38,400	£24,950
Labour cost of finishing scrap	£21,100	£7,750
Compression Scrap		
Labour cost of moulding scrap	£49,450	£32,700
Labour cost of finishing scrap	£15,600	£ 5,600
Total Labour Costs	£114,550 p.a.	£71,000 p.a.
Materials Costs of Scrap	£26,200 p.a.	£21,600 p.a.

Therefore from these figures we might expect labour savings of £44,000 p.a. and material savings of £5,000 p.a. However, the savings from the projects on conversion of compression parts involved a large element of scrap saving, in fact, estimates based on the figures prepared for the evaluation indicate that labour savings by reduced scrap would be approximately £15,000 p.a. and this had already been claimed. Thus the net effect of fall in scrap levels would be a saving in the region of £32,000 p.a.

11.3.1.4. Summary of Effects

1. Projects	+ £99,000 p.a.
2. Wage Increases	- £81,000 p.a.
3. Fall in Maintenance Costs	+ £32,000 p.a.
4. Fall in Scrap Levels	+ £32,000 p.a.
Also included a fall in Fringe Benefits	+ £13,000 p.a.

NET EFFECT ON VARIABLE COSTS = + £95,000 p.a.

From the factors of change analysed a decrease in variable costs of £95,000 p.a. would be anticipated, this compares favourably with the actual change of £97,000 p.a. However, it would theoretically have been possible to pursue the analysis further, by considering other factors e.g. the effects of change in product mix on materials and labour costs had data been available. Indeed Table 11.7 shows that material costs had risen by £6,000 p.a. but the change was small and data on possible causes very limited. In the ideal situation the investigation would begin by compiling a list of all actions or changes that directly, or indirectly affected the area during the period under consideration and evaluating the effect of each action. This more detailed approach is discussed at some length in the G.R.A. manual (appendix H.)

11.3.2. Changes in Fixed Costs (Increase of £20,000 p.a.)

Little could be said about the cause of increase since the costs were allocated by the Accounts Department, and a breakdown of the allocation was not available. However it appeared reasonable to suggest that a possible cause was an increase in the salaries of factory staff, since these salaries accounted for a major portion of costs and increases had been awarded.

11.4. Final Summary and Comments on Reasons for Change in Profitability

Profit/loss changed from - £316,000 p.a. - 1971
to + £29,000 p.a. - 1973

i.e. A change equivalent to an increase in profits of £345,000 p.a. In the table of suggested causes below, the positive sign is used to indicate an increase in profit, and the negative sign a decrease.

Suggested causes of change

Volume Change	=	0
Product Mix Change	=	+ £111,000 p.a.
Price Change	=	+ £171,000 p.a.
Changes Arising from Projects	=	+ £99,000 p.a.
Organisational Changes *	=	- £24,000 p.a.
Misc. Income Change	=	- £13,000 p.a.
Total Change in Profitability		+ £344,000 p.a.

* - Breakdown of organisational changes :

Wages Increase	- £81,000 p.a.
Mainteance Cost Actions	+ £32,000 p.a.
Changes in Scrap Levels	+ £32,000 p.a.
Change in Fringe Benefits	+ £13,000 p.a.
Change in Fixed Costs	- £20,000 p.a.
NET EFFECT	- £24,000 p.a.

Table 11.8

Comments

1. One of the most important facts to emerge from the analysis was the effect of change in product mix; in this instant the change was very much to the department's advantage. However, the increase served to highlight an important aspect of revenue that was basically not under departmental control, since the schedule was to a great extent determined by the customer. Therefore the analysis forewarned the department to be more aware of possible implications in changes to the schedule, and indicated that these changes might be manipulated to advantage.

2. The results indicated that the management of variables within the department had been good, because as a result of Project Work and Organisational Changes, the increase in wages paid to operatives had been more than compensated for.

3. This lead to a suggestion by Mr.Air that the data in Table 11.8. could be presented in a slightly different manner, that would reflect the above actions in the light of the general effects of inflation.

e.g. He expected that over the period, price increases totalling £100,000 p.a. might be expected. In the same vein, wages would not be expected to remain stable, so increases of £80,000 p.a. for operatives and £15,000 p.a. for staff (reflected in the change in Fixed Costs) might also be expected. The summary would then be as follows :

Volume Change	0
Mix Change	+ £111,000 p.a.
Price Change	+ £ 71,000 p.a.
Misc. Income Change	- £ 13,000 p.a.
Projects	+ £ 99,000 p.a.
Organisational Change	+ £ 71,000 p.a.
NET EFFECT	+ £339,000 p.a.
Inflationary Effects	+ £ 5,000 p.a.
(Price Changes	+ £100,000 p.a.)
(Wages Changes	- £ 95,000 p.a.)

4. Finally the analysis had shown the value of the Project Work, since without the work the department would still have been running at a loss of £70,000 p.a. This meant that not only had morale within the department improved, but also customer relations were also greatly improved and the department was now moving to a situation where extra business and a stronger market position could be considered.

Chapter 12.

Attempts to perform further Profit Improvement Programmes

As shown in the previous chapter, the approach adopted during research offered a method of predicting and achieving profit improvement. Since the work was being performed for Dunlop it was agreed that further savings should be attempted, but this time with company employees performing the various stages of the approach. The author's task was therefore to instruct and guide members of the factory staff in the approach used and to write a manual which would serve as a standard reference work for anyone attempting such work.

12.1. Production of Manuals.

The production of a manual describing the stages and techniques of the approach used during profit improvement seemed a logical starting point.

Firstly, it provided the author with an opportunity to formalise his ideas on the subject of profit improvement, prior to instructing others in the method. Secondly, a good manual would aid the instruction of others in the method, hopefully providing a guide/reference work. Thirdly, it would provide the company with a permanent example of a method of approach after my departure.

A manual titled "An approach to Profit Improvement" was produced, a copy of which is to be found in appendix G. The approach covers twelve stages in apptempting a profit improvement programme; from the understanding of the structure and relative importance of variable cost areas for the generation of ideas, to the review of the effects of individual elements/projects performed during the programme.

The manual was written for junior or lower level management, i.e. up to departmental manager level in the Skelmersdale factory structure. It assumed a modicum of further education from the reader, though certainly not of University standard, combined with a rudimentary understanding of simple accounting technology. These general requirements were met by the three individuals selected to perform the repetition of profit improvement work.

A second manual was produced to cover the final stage of the approach; the review of the effects of the programme. This was written in the light of experience of post-project evaluation, which had shown the importance of identifying the various causes of profit improvement.

The second manual, titled "Gross Retrospective Analysis (for financial investigators to implement)" is to be found in Appendix H. The aim of the manual is to provide a method of highlighting the underlying causes of change in profitability.

The main body of the manual is split into two sections, indicating possible methods for identifying changes in Revenue and Total Costs, hence changes in profit. An unexpected result of producing this particular manual was the highlighting of a particular cause of change in sales revenue, which could be either overlooked or avoided depending on definitions adopted for the causes of change. The cause is referred to by the author as the interaction effect, and its implications are discussed in some detail in the manual.

For the benefit of the reader, a brief discussion of the affect is given below :

- if we call the price of a given item P, and P+dP, for periods 1 and 2 respectively; where dP represents a change in price
- and adopting a similar convention for the quantity of the item sold in the two periods, i.e. V and V+dV.

Then we can call the sales revenue for the two periods PxV and (P+dP) x (V+dV)

$\therefore$ The difference in revenue = (P+dP) x (V+dV) - P.V.

= P.V. + P.dV + V.dP + dV.dP - P.V.

= P.dV + V.dP + dP.dV.

Then if by definition :

i. P.dV = Original Price x Change in Volume.

= Effect on revenue of a change in volume of item

and similarly ii. V.dP = Effect on revenue of a change in price of item.

We are then left with dP.dV = The interaction effect, or the combined effect of a price and a volume change on revenue.

Obviously if either the price or the volume remains constant dP.dV=0. However anyone attempting an analysis of the causes of change in sales revenue over a period of time, should be aware of the possible implications of the effect. In fact, the author only came to appreciate the effect and its implications whilst writing the manual and formulating definitions for the causes of change; and a more detailed discussion of the effect is to be found in Appendix 2 of the

G.R.A. Manual (appendix H).

Again this manual was written for junior management, to serve the duel purpose of identifying causes of change and indicating the potential relative importance of actions in various areas on the overall financial situation.
Unfortunately, the G.R.A. Manual has yet to be used, and its effectiveness as instructional or communication media remains untested.

12.2. Attempts by Dunlop Personnel to establish Profit Improvement Programmes.

As stated earlier it was agreed that the aim of this final stage of the project was to attempt to repeat the work performed in the Lockheed Department. This decision was to provide the opportunity to assess a number of aspects of the project work. For example, what particular qualities were required to successfully perform this type of work, and to what extent could the approach succeed in different "environments". To this end three areas were chosen in which to repeat the work. These were :

i. The Lockheed Department. Here the approach had succeeded and whilst considerable improvement had been made in profitability, there appeared to be room for further improvement. The individual chosen to perform the work was a "process engineer", who had a degree in chemistry and a good understanding of the technology of process, combined with a considerable degree of personal ambition. He showed a willingness to learn and co-operate in the project, which he felt might further his career.

ii. The Girling Department. As mentioned in earlier chapters, this department was producing the same product as the Lockheed Department, but at a profit rather than a loss. The department, established in the early sixties, was producing brake seals for Girling Limited, It differed from the Lockheed Department in that A) It was manufacturing mostly seals and only a small number of covers, and B) All the moulding machinery was compression equipment. So the approach could be tested in a similar manufacturing unit which was apparently operating successfully.

The choice of researcher in this case was a "senior process engineer" with engineering qualifications and a strong engineering bias. His attitude to the work was hostile resistance in the initial stages, expressing reluctance at "taking orders from a student".
The situation was further complicated by his position of open hostility towards the departmental manager. Indeed his eventual agreement to participate may have been partially motivated by a desire to further his own cause against the departmental manager. However to his credit the work he performed he did conscientiously and showed considerable understanding of the situation, and potential areas for improvement.

iii. <u>The Proofing Department.</u> This represented an environment which was totally different to the Lockheed Department. Firstly, the Department was highly profitable, and secondly the product was highly material intensive, with only a small labour element in the cost of production. In this case it was hoped to test the approach in a potentionally less receptive environment.
Again, as in the Girling Department, the researcher was a senior process engineer. However, he was prepared to co-operate from the start, and felt that he would benefit from using the approach.

The choice of process engineers was not intentional. The individuals were chosen by the Product Manager and the author as the most suitable personnel within the departments.
Instruction in the approach was provided by firstly allowing the individuals to read the manual and then discussingthe approach with each in turn. This produced the opportunity to gauge reaction to the manual, and assess its effectiveness as an instructional aid. All found the manual easy to follow and they felt that much of it was basically common sense. Discussion indicated that the aims and method of approach had been understood, and the manual appeared to have succeeded in its function.
Once the author had established to his own satisfaction that the researchers understood the approach, work began in each area.
Following a brief examination of the departmental accounts, it was agreed that each researcher would produce labour and material cost models and then use these to investigate the costs of scrap.
Work began in December 1973, and, in an attempt to establish a sound start to the projects the author provided assistance with the data collection for model building. In fact this stage

progressed reasonably well with the cost models being produced in the manner recommended in the manual. Then, following an analysis of available scrap data, the models were used to evaluate the labour and materials costs of scrap. The models and figures are to be found in Appendix I.

Unfortunately at this stage external factors resulted in complete disruption of the work. As the Miners' strike progressed and the "Power Crisis" developed, the factory was forced onto a three day week. The immediate effect of this action was the concentration of all management resources into problems created by the situation. This, of course, resulted in suspension of all the project work, highlighting the problems of attempting to conduct research in a real environment.

As can be appreciated, the effects of the three day week continued to be felt after the resumption of normal working, with efforts directed to the return to levels of maximum output in the face of material shortages.

It was not possible to attempt to re-establish the project work until May 1974, when the situation was beginning to return to normal. Unfortunately, the suspension of activity for a three or four month period had resulted in considerable loss of interest by the individuals involved. Also, Mr.Air had left the factory to take up an appointment in Coventry, and his departure may have reduced the personal motivation of the researchers. Furthermore, the author was now committed almost full time to production of the thesis, and unable to devote sufficient time to ensuring that the projects were successfully resumed.

In fact, virtually no further progress was made in any of the projects, and this approach has not been re-attempted again to my knowledge.

12.3. Conclusions

The reactions of the three researchers to the manual was favourable. They found it instructive and easy to follow, and appeared to understand the principles outlined. The models produced were as intended when the manual was written, and initial attempts at evaluating ideas were performed along the lines proposed. But this work, was of course, only a small portion of the approach and the remainder, including the second manual on financial analysis of results remained untried.

There were indications that the relation of the individual to the firm and motivation were important factors. Certainly, the independent agent is unaffected by any ties to the firm, and is not expected to divide his time between objective research and routine work. For the independent agent there is no conflict of loyalty, and the adoption of an objective standpoint will be even more difficult for an individual working from within the firm.

Also for the company employee, motivation may present more of a problem. In this case it is doubtful whether sufficient consideration was given to the question, and in one case, (the Girling Department), the reasons for performing the work were questionable.

So there are pointers that if this type of approach is to succeed, the possibility of success is likely to be increased by adopting the approach of an independent agent. However, an independent agent will only succeed provided he can establish a satisfactory relationship with the environment in which he is working. Indeed, it could be said that lack of management and individual motivation strengthens the need for an intellectual non-involved approach in this type of work, a claim that is supported by the success of many independent consultancy firms.

Chapter 13

Literature Survey

The first point that may strike the reader is the unconventional position of the survey in this thesis. As a rule a literature review appears near the beginning of a traditional thesis, often following the definition of the problem or problem area. In such cases the purpose of the survey is to familiarise the researcher with the existing body of knowledge, and possibly to indicate promising avenues for investigation of the problem. Therefore before commencing the survey the reasons for its unconventional position are outlined.

Firstly, the project was ill-defined during the initial stages, and the early part of the work was to define a project. The field would have been far too wide to cover, and in any case (and perhaps because reading could only have been selective) there might have been a danger of seizing upon specific topics, or techniques because they had been mentioned in the literature. It was therefore thought better to make an evaluation of the whole process as objectively and scientifically as possible.

Secondly, at this stage, and afterwards when things were becoming more clearly defined, the situation within the department was rapidly changing and did not permit a leisurely study of literature.

Thirdly, a quick assessment of what had been written seemed to show that practically nothing in the "recognised" lierature was of direct use - i.e. could be taken and simply applied -, but a very great deal was of general peripheral relevance.

In view of the second reason mentioned above, the literature was not reviewed at this stage; but past experience, both at the firm via the management involved and the university via the main supervisor, was drawn upon.

Now that the project had been carried out successfully in terms of the aims of Dunlop, it was of interest to see how the results fitted into the current state of knowledge and experience in certain areas as reported in literature e.g. did the practical examples of successful project implementation/cost saving confirm, refute or fill gaps in current thinking?.

In fact the survey was not performed until most of the work at the factory was nearing completion, and the position of the survey in the thesis is an accurate reflection of its chronological position. This is a reflection of research conducted in a 'live/on-going' environment, where decisions on actions affecting the course of research have to be taken in the face of real constraints.

13.1. Aims and Areas of the Search

Having indicated the reasons for the unusual position of the survey in this thesis, it is also necessary to consider the purpose of the search. Obviously it must attempt to perform a rather different function to its more traditional use.

As the survey was conducted after the completion of the main body of research, the primary aim of survey was to provide the basis for a retrospective assessment of the work done, comparing it with existing theories and data.

With this aim in view the survey was conducted on two levels:

1. A General level - covering approaches to cost reduction/profit improvement, the evaluation of ideas and project management in such approaches.
2. A more detailed/specific level - covering areas that appeared important to the success of the work, or produced criticism about the approach adopted to them.

e.g. i. Creativity and the ideas generated for profit improvement.
ii. The problems of implementation of ideas.
iii. The role of the researcher in industry, and the attitudes/relationships experienced during the project.

13.2. A General Review of Literature

The first stage of the review consisted of an examination of the weekly summary of contents of journals received by the Manchester Business School Library, in an attempt to locate relevant articles. This phase covered two years publications i.e. 1973 and 1972. Then the search was extended to 1971 publications of those journals that had yielded potentially useful articles in the initial phase. In all some 60 apparently relevant titles were found. However, more detailed examination showed that only one third were of direct relevance.

A complete list of the 60 or so articles is to be found in Appendix J as they may be of use to other researchers.

13.2.1. Cost Reduction/Profit Improvement

The majority of authors appeared to advocate cost reduction actions, rather than attempts to increase sales or selling prices, as the most effective means of achieving profit improvement (e.g. Refs. King (1973).

This was not the case in the Lockheed Department, since the analysis of the change in the department's financial situation had shown that price increases had made a greater contribution than cost reduction to profit improvement (see Chapter 11). This may be an indication of the unusual circumstances of the department when research began, and also a reflection of the more 'typical' situation envisaged by the authors.

Certainly no reference was made in any articles to the additional problems of conducting profit improvement work in a factory losing money. In such a situation constraints like the need for quick action, lack of capital for projects, or even poor morale within the organisation can be encountered.

Most authors preferred variable cost areas as prime targets for cost reduction programmes, although articles were to be found indicating that non operational or fixed cost reductions could lead to significant profit improvement e.g. E.Michaels (1970).

For a number of reasons already mentioned in Chapter 3, the author's own efforts had concentrated on variable costs.

A number of different approaches were suggested for selection of areas for action, and these are described and discussed below :

a. Business Appraisal - Chambers (1970)

- The approach examines a number of key areas in which strengths and weaknesses can be assessed e.g.

Financial Resources - A quick assessment can be performed by looking at cash flows, and financial ratios (similar to an Interfirm Comparison).

Profitability - Establish which activities are providing the bulk of the revenue, and analyse operating costs.

Product Range - Analysis by product of profit, resources used, market share, etc.

Other Key Areas: Functional Capabilities, Human Resources and Organisation.

b. Use of Value Analysis for Profit Improvement - Mason (1971)

- Application of functional/cost/value relationship to almost all phases of business. Also the use of cost centres and cost centre control data.

Indicates possible areas for consideration e.g.

Product Standardisation
Plant Layout
Materials Handling
Inventory Control
Quality Control etc.

c. Cost or Cost Structure Analysis - Kozma (1973), Smith and Ray (1973)

- Basic cost analysis for cost reduction and planning for profit. Procedures outlined to identify those costs most readily controlled, and to help concentrate effort on areas in which savings can be made.

d. Component Analysis - Slater (1973)

- An analytical approach using a "Return on Investment Tree" - similar to the pyramid of accounting ratios used in Interfirm Comparisons (see Chapter 8), to concentrate on a small number of activities that have the greatest effect on profit and R.O.I.

The approach consists of five basic steps :

i. Draw the R.O.I. Tree
ii. Expand the major components of the tree.
iii. Identify actions to influence components.
iv. Perform a sensistivity analysis - helps to determine those elements having a major effect on profit and R.O.I.
v. Rank Components.

e. Planning for Cost Reduction - Bayer (1973)

- A method of deciding where to apply a cost reduction programme. The application of Pareto's Principle of Maldistribution to separate many in-consequential areas from the vital few. The Principle would be used in the following approach or programme:

i. Establish goal
ii. Decide where to work by analysing the losses - "Paratoize"
iii. Determine the cause of the problem.
iv. Determine the necessary action and implement.
v. Corrective Action follow-up - a check that savings have been maintained.
vi. Develop a Control System - to ensure that the problem does not reappear.
vii. Reduce the cost of the programme i.e. reduction of programme staff.
viii. Audit the programme.

f. <u>Six Phases of Cost Reduction</u> - King (1973)

- Cost reduction should be a systematic study based on facts as an approach to increasing profit by reducing variable costs. The 6 phases are :

Phase I - Planning and Scheduling Activity

II - Background Analysis - gathering of data, performing work measurement, observing and analysing activities, charting flows, and collecting improvement ideas from management.

III - Examination of all data, generation of further ideas, and development of all improvement ideas plus determination of all facts needed to evaluate them.

IV - Collection of further Data and Evaluation of ideas. Submission of Recommendations.

V - Formation of Implementation Action Plan.

VI - Implementation of the Plan and Follow-up to ensure savings obtained.

The production of these alternatives posed a number of questions. Firstly, which of the methods could have been used in the initial phase of research, and would they have been any more effective than the method adopted? The basic cost data required by the first three approaches was not readily available, and any existing cost data was of dubious quality. Also, the gravity of the financial situation and dominant position of labour costs in the variable cost sector meant that labour reduction was a priority. Indeed this last comment would apply to all the approaches, and it can be assumed that in terms of recognition of areas for action the simple examination of the accounts was quite sufficient.

Component Analysis appears similar to the production of accounting ratios for the Interfirm Comparison, and for that reason the general comments about the I.F. Comparison in Chapter 8 can also be made about this approach.

The application of Pareto's Principle of Maldistribution in the planning approach suggested by Bayer might have proved a useful tool especially in the analysis of scrap costs. However, it is doubtful whether the data available within the department would have been suitable for its application.

Finally, the 6 phases of cost reduction suggested by King. In many ways these are similar to the approach adopted during research and outline in the manual on profit improvement work. The major difference between this, and indeed the majority of the other approaches, and my approach is the need for a team to perform the work. Certainly the background analysis proposed by King in his phase II would require a team to complete the study within his suggested period of ten days. The introduction of a team does raise further problems namely recruitment, costs of running the team, and possibly whether the approach will be as objective as that of the independent agent, although it must be said that in many cases the size and nature of the problem may dictate the need for a team.

The one general comment that does emerge is the difficulty of adoption of these approaches in a situation, such as the Lockheed Department in 1971, where there is a general lack of detailed financial and costing data.

13.2.2. Evaluation and Selection of Profit Improvement Projects.

The articles found under this heading e.g. Buckley (1972), Chambers (1970) and Zaloom (1973), were generally covering evaluation of capital investmen projects and discussed the various merits of Net Cash Flow Analysis, Discounted Cash Flow, Net Present Value etc. Course work during the early stages of research had covered these areas in general terms, and descriptions were available in many of the standard accounting text books. The nature of the 'Quick and Dirty' Analysis had meant however, that the methods mentioned above had not been used. In the majority of ideas capital expenditure was so small in comparison to estimated savings that the more sophisticated methods of evaluation were not used.

No literature was found on this simple yet objective approach to evaluation. This may have been because the search was not sufficiently comprehensive, but another possible reason was that the approach would generally be considered 'common sense' or a statement of the obvious. However, I contend that the achievement of a satisfactory evaluation from "Quick and Dirty" Analysis requires more self discipline in facing the more difficult and unpleasant arguments than is implied by the "common sense" title. Personal experience has shown that in a 'live' situation political pressures can influence the evaluations unless a completely objective approach is adopted.

13.2.3. Project Management.

The review revealed one major source of project management literature, namely the systems management area. However, investigation revealed that the methods covered were in the main network techniques designed for control of computer/systems projects e.g. Frankwicz (1973), Weiss (1973) and Whitehouse (1973), or the use of computer cost models for appraising the progress of large projects-Thompson and Whitman (1973).

A systems oriented article by Jacobs (1972) did suggest possible causes of failure, which could be considered applicable to project management in general. These causes are shown in table 13.1., which is an attempt to summarise causes of failure as listed by various authors.

The table is based on a list, compiled by Watling and Taylor (1973), of causes of failure to civil engineering projects. However, many of the causes are sufficiently general to be applicable to most areas of project management.

In retrospect a large number of these potential causes of trouble appear to have been anticipated by the approach adopted to manage project work in the Lockheed Department. The climate for success was partially achieved by communication of the aims of the overall programme to all concerned at the outset, and also by discussions with individual project leaders. Areas of responsibility were defined and acceptance of responsibility and setting of targets were forthcoming from the individuals in the programme. Progress was effectively monitored, and control information was readily available for the Project Work Co-ordinator. The problems of implementation are reviewed in more detail later in this chapter.

	WATLING AND TAYLOR	JACOBS	AVOTS	JONASON
1. Unclear Aims .	I			
2. Inadequate control of variations from plan.	I	I		I
3. Poor initial evaluation	I			
4. Inadequate project management	I	I	I	
5. Confusion of responsibility	I	I	I	
6. Failure to monitor progress effectively	I			I
7. Failure to identify critical areas	I			
8. Inadequate information flow for control	I			
9. Failure of sub contractors	I			
10. Faulty equipment	I			
11. Labour troubles	I			
12. Accidents	I			
13. Bad weather	I			
14. Failure to establish the proper "climate" for success		I		
15. Manner of setting targets			I	
16. Inadequate communication to the outside environment				I
17. Failure to recognise the needs and attitudes of all personnel involved			I	I
18. An ineffective project management structure.			I	

POTENTIAL CAUSES OF FAILURE OF PROJECTS

TABLE 13.1

13.3. A Review of Literature Relating to Specific Aspects of Project Work.

As indicated earlier in this chapter, the literature survey was performed on two "levels". The second level enabled the author to compare various aspects of the project work with 'established theory'.

13.3.1. Creativity

The first area for review was the creative quality of ideas generated for the profit improvement programme.

The Works Manager (Mr.D.Air) expressed disappointment over the apparent lack of originality in ideas presented to him for profit improvement. He felt that many of the ideas had been voiced by various members of staff, prior to my arrival, in one form or another. Although he did concede that they had not been presented or evaluated in the manner the author adopted, nonetheless, he had been expecting something more innovatory and less 'run of the mill'.

Whilst the author contends that this situation arose partly from an ineffective consultant/client relationship between himself and Mr.Air, it is also worth examining ways in which more creative ideas might have been produced.
Therefore in order to review alternative approaches that might have been adopted to general ideas, a number of texts on 'creative thinking' were studied. These are outlined below:

- "Creative thinking produces new and useful ideas, whilst original thinking produces new, but not necessarily useful ideas".-
Therefore in a pratical research environment, such as encountered in the Lockheed Department, the need is very definitely for "Creative Ideas".

As with all approaches to creativity Whiting stresses the importance of suppressing judgement and evaluation during the creative process.

This repression of natural instinct in this and other areas is very much a feature of De Bono's (1971) Lateral Thinking. Here, in addition, the thinker must not only suppress judgement of ideas, but must also 'escape' from the patterning of behaviour of the mind typified by the logical or vertical thinking process. To the uninitiated the principles of Lateral Thinking are in themselves a challenge to the individual seeking creative inspiration, especially to the 'scientist' whose discipline is based on vertical thinking.

i.e. Vertical thinking is based on the rejection function - we cannot proceed unless the next step is acceptable, and judgement, evaluation and criticism are all derived from a negative basis or No function. Lateral thinking protects ideas from the rejection function.

In fact De Bono states that lateral thinking is very difficult to learn for the following reasons:

i. - It contradicts many of the traditional habits of thinking, established by education.

ii. - It is unnatural, in so far as the natural tendency of the mind is to create and maintain rigid patterns.

iii. - It encourages open ended ambiguity, which may make people unhappy by lack of security.

Indeed, the author tends to agree with G.Tarr (1973) who feels that De Bono offers escape techniques from vertical thinking rather than training in a new method of thinking.

Lateral thinking is a method for the individual to adopt either in isolation or a group 'brainstorming' session.
"Brainstorming" appears to be attributed to A.Osborne (1953) who also introduced the principle of suspended judgement mentioned earlier, to release the free flow of ideas during group discussions. He felt the actual creative process, without any rigid sequence, consisted of some or all of the following phases:

i.	Orientation	:	'Pointing-up' the problem
ii.	Preparation	:	Gathering pertinent data
iii.	Analysis	:	Breaking down relevant material
iv.	Hypothesis	:	Collection of alternatives by way of Ideas
V.	Incubation	:	
vi.	Synthesis	:	Putting the 'pieces' together
vii.	Verification	:	Judging the resultant ideas.

Then the brainstorming groups of 5 to 10 participants followed the rules of : i. Suspended Judgement ii. Encouraged Free-Wheeling of thinking iii. Quality of ideas sought iv. Followed by combination and improvement.

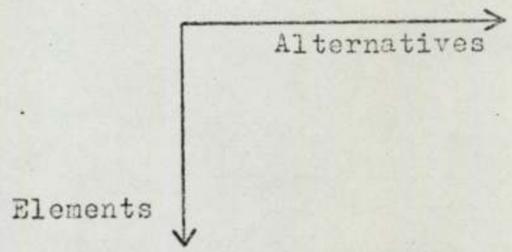
These rules are echoed by C.A.Clark (1958) as basic ingredients for good brainstorming; which he contends also results from spontaneity arising from good planning of the session.

Opinion appears somewhat divided as to whether Group participation inhibits or facilitates creative thinking e.g. Ref. Lorge etal (1958) and Taylor. etal (1956). The use of a group approach is obviously of limited value to an independent research agent.

There are other approaches that might be considered aids to brainstorming e.g. Zwicky's Morphology approach. The search for solutions to a problem is made by examining all combinations of all possible elements of the problem.

By breaking the problem down into separate elements and then providing as many values as can be imagined to each element, a chart or matrix is formed.

<u>Morphological Chart</u>



Then by studying all possible vertical chains, we have all the possible solutions to the problem.

One obvious problem with such an approach is the amount of work involved, building the chart and then eliminating those elements or alternatives that produce impractical solutions.

Similar approaches are suggested by J.Webb Young (1940),in so far as a new idea is a new combination of existing diverse elements into new patterns.

Along a different track, there is the possibility of getting ideas from nature (Bionics) as suggested by Dr.Watson Geradin (ref.Burnet). One obvious example is the development of radar, resulting from investigations into how bats navigate in the dark.

A final source of creative ideas is "serendipity", or the unexpected discovery by 'happy accident'. It would seem that the only art in such an approach is being aware that it can happen, and being prepared for it when it does; a case of chance favouring the prepared mind.

This review is perhaps best summarised by a quote from an article by F.D.Barnett (1972).

- "A popular fallacy is that new ideas are produced by cleverness or brilliance. In other words they emanate from exercises in adroit mental gymnastics.

In fact this is not how it happens. The way is a great deal simpler and much more difficult.

Ideas come from changing ones view point about something".

Indeed one of the reasons that it is hard to produce NEW ideas, and even harder to accept someone elses, is that we have to change to do so.

As we have seen there are many ways of generating ideas and in a number of cases adoption of a particular method would have required considerable time and effort simply to "train" oneself in the approach or to collect and analyse preliminary data. Without firm assurances that such approaches would produce satisfactory results, it would be difficult therefore to recommend that they be adopted in preference to a more orthodox approach.

A final point should be made in defence of the ideas produced in terms of the overall project. It was said earlier that to accept someone else's idea we have to change to do so. In terms of successful implementation of ideas, it is vital that those directly involved in implementation accept the idea. Therefore, the fact that some of the ideas came from the individuals implementing the programme, aided successful completion of the programme, as there was little personal acceptance or change required.

13.3.2. Implementation of Research Recommendations

There were two main reasons for performing a review of literature on "implementation". The first was that this was a vital phase of the project work, providing an opportunity to test the validity of the recommendations proposed. Secondly, general discussions with various members of university staff indicated that lack of successful implementation of proposed solutions was a major failing of Operational Research, a feeling borne out by the literature survey. This latter point may well be an overstatement of the case, possibly resulting from the considerable emphasis placed on the importance of implementation by the O.R.profession, which in turn tends to highlight failure in this area.

On a somewhat superficial, but none the less valid level Tarr, Watling and Taylor all stress the importance of presenting a solution in a clear well argued manner. Solutions which are correct do not necessarily gain acceptance, and sometimes special skills of presentation are required. Also Tarr contends that determination of the nature of the audience, and the time of presentation are important. Incidently all three recommend that long reports should be divided into two sections. The first a short volume containing a summary and giving recommendations. The second volume providing details of the recommendations. This was in fact the format adopted for the presentation of long reports to senior management.

However, these comments offer little more than obvious guidelines for gaining acceptance for the principles of implementation in individual cases, and do not attempt to seek causes of failure to achieve the proposed solution.

A number of authors have produced papers indicating reasons for failure to achieve successful implementation; some of these are reviewed below :

i. Malcolm (1965) describes two major aspects of the difficulty of implementing O.R.results; a) the difficulties of assessing the cost of implementation.
b) the failure of the researcher to accept the presence or problems of such a phase of research. He argues that O.R. should be approached as a continuum of effort, starting with the basic research leading up to implementation, with implementation being added to the function of the O.R.group or researcher.

ii. Stilson (1963) offers two possible extreme definitions for the successful implementation of an O.R. problem namely:

A. A retrospective evaluation of an operational period which indicated that the solution would have been acceptable, compared with the actual operation during the period.

B. The adoption of the O.R.model and procedures into routine use by operating personnel achieving the predicted optimum solution.

Between these extremes he presents a number of concepts essential to implementation, amongst which are :

1. Effective communication between scientist and manager

2. An examination of the steps required to make the changes.

3. The development of controls for continuous review of the solution and those personnel operating it.

As in the case of the previous author , he cites uncertainty of implementation costs and lack of interest by the researcher in the problems of implementation, as reasons for failure to achieve proposed solutions.

Also, in an attempt to overcome these causes, he concludes that the researcher should get "closer" to the operation he is studying, in order to obtain better insight into these problems.

iii. Tate (1969) considers the success of implementation to be one of the main criteria by which an O.R. project must be judged. He also contends that there are two widely different types of technique required to perform a successful O.R. project. The first is the group of techniques needed and used in the model-building and evaluation stages of the project, these he calls the techniques of O.R. Quite distinct from these techniques, he proposed that the researcher should also adopt a technique to research that accepts that successful implementation will not simply arise from satisfactory manipulation of the "techniques".

Very simply his technique is a matter of client indentification combined with continued communication to the client throughout the phases of the project. The purpose of the approach is to obtain commitment to each phase of work from the client, thereby increasing the likelihood of successful implementation. Such a technique he believes "requires a more physical than intellectual ability", calling for a personal determination "to meet with and talk to management, understand them, and communicate with them".

He considers that the practice of the techniques and a technique of O.R. require widely different personal qualities, and until this is recognised by practitioners the possibility of failure remains likely. An opinion shared to some extent by Banbury who also feels that success in O.R. may depend more on "interpersonal rather than rational skills".

iv. Ratoosh (1966) describes a set of experiments performed to attempt to answer two questions :

A. What can a research team do to maximise the organisations acceptance of research results?

B. What is the nature of resistance to implementation?

The experiments appeared somewhat inconclusive, but one tentative conclusion was that sound presentation of the results together with persistent active support from within the "organisation" increased the likelihood of implementation.

However, he does believe that implementation of research results is a legitimate part of O.R., and the neglect of such problems renders O.R. "sterile and ineffectual". A possible cause of the reluctance by the traditional O.R. worker to become involved is his "pure/applied" science background, which is unsuited to this human/social science field.

The underlining theme of all these articles is the need for the researcher to increase his commitment to overcoming implementation problems, mainly by coming to terms with the human elements in the systems.

Churchman who collaborated with Ratoosh in the experiments mentioned above and Schainblatt (1965) have taken this theme one step further, calling for an attempt at "Mutual Understanding" between scientist and manager, as the way to overcome the problem. A paper reviewing opinions on implementation indicated four distinct ideas about the relationship between the scientist and manager that could be adopted.

These are outlined below :

1. Separate function position - which sees management and research as completely separate functions.

   The researcher will produce a complete solution, which the manager must then accept or reject.

2. Communication Position - emphasises the need for more understanding on the managers part. The philosophy of this approach is that implementation is essentially a matter of understanding science.

3. Persuasion Position - implementation centres around the understanding of the managers role, i.e. the scientist understand enough about the manager to overcome resistance to change.

4. Mutual Understanding Position - embraces the positive aspects of positions 2 and 3, and advocates a 'union' of manager and scientist.

   This is the position advocated by the authors, and it requires an effort by both parties to reach such a position.

The authors formed these ideas into a matrix shown below :

	B	B'
A	Mutual Understanding	Communication
A'	Persuasion	Separate Function

A(A') - Manager does (not) understand the researcher

B(B') - Scientist does (not) understand the manager.

This matrix and the article gave rise to considerable comment from various distinguished authors, the majority of whom agreed with the position advocated by Churchman and Schainbentt. Amongst those who supported the "Mutual Understanding" positions were Abrams, Beer, Evans, Geisler, Littauer, Starr, and with certain reservations Alderson and Bennis (1965).

Alderson (1965) considered a deficiency of the paper to be the lack of consideration for management motivation. He proposes a further matrix to account for the motivation behind the research.

	Direct Need	No Direct Need
Substantive	Decision Seeking	Service Studes
Negotiative	Conciliating	Ritualistic.

Alderson identifies management motivation and suggests attitudes that the scientist might adopt in each case. e.g.

i. Decision Seeking - The manager has a real decision problem and is actively seeking a solution. In such a case the scientist should understand all psychological, social and career implications in order to produce recommendations that will favourably influence management behaviour.

ii. Conciliating - Where research is to be used to reconcile diverse management viewpoints. Such a study would not be wholly objective and would converge to a workable solution. This might be a good time for the scientist to adopt a "Persuasion" position.

iii. Service Studes - research authorised with no direct need for solution, such as a market research survey conducted for customers. Here, results and recommendations may have to be tailored to suit the needs of the end uses and "Communication" maybe required.

iv. Ritualistic - the case where the study is being used to indicate that an attempt is being made to solve a problem; but the manager has little hope of finding an acceptable solution. Here the researcher can be as objective as possible and might well benefit from the adoption of the "Separatist" position.

Therefore Alderson is proposing a dialectic between the two matrices, with Churchman and Schainblatts "Persuasion" appearing with a Conciliating Study, Communication with Service Study, and the Separate function with a Ritualistic Study.

On the other hand Bennis (1965) feels that the proposed concept of "mutual understanding" is somewhat unclear, although he agrees that good relationships can be built from trust and valid communication. In a later paper (1969) on the "Nature of Planned Change", he includes the collaborative relationship as one of the four elements of planned change. The basic elements are a change agent, the client system, valid knowledge, and a collaborative relationship.

Whilst he is basically concerned with implementation of organisational changes, many of his conclusions are applicable to all types of implementation. His definition of implementation as "a process which includes the creation of understanding and commitment in a client system towards a particular change which can solve problems, and devices whereby it can become integral to the clients systems of operations", must surely embody those features of a successful operational research project. Inherent in his conclusions is the fact that acceptance of a solution depends on the relationship between change agent and client system.

However as with Sofer (1961), Bennis indicates that the development of this relationship may tend to jepordise the objectivity of the change agent. So once again the researcher is faced with a conflict of priorities, as in the case of Tate's call for techniques and a technique.

A subjective reflection on the project work performed in the Lockheed Department does appear to support the necessity to find a compromise, which resolves these conflicts. The author feels certain that the presentation of evaluated ideas in a simple logical fashion proved an aid to managements understanding of the work, yet the approach retained the discipline of scientific method. This understanding was further aided by the regular discussion of all aspects of work at all management levels. Obviously, a major feature of success was the willingness on the part of the staff to participate in discussion, and I would hold that this is a very important part of development of a "mutual understanding" relationship.

Furthermore from the development of such relationships, the author was able to experience "spin-off" effects of requests for help/advice in other areas not specifically related to the project. These were somewhat similar to those experienced by Sofer (1961) as a 'social consultant', and are indicative of a state of 'trust'. Examples of this range from the explanation of accounting figures to a "middle" manager, and production of important forecasting data, to discussions on personal problems such as his childrens careers. Out of context these examples may appear rather trivial, but must provide a pointer to the type of relationship that was established.

Another relevant comment was that of my Industrial Supervisor, who felt that to a certain extent I had produced the effect of a catalyst. This indicates that the "state" had been right for a successful 'reaction', but to be effective the catalyst must be compatible with the basic ingredients. Also the conditions of a catalytic reaction must be met, therefore to be a successful catalyst the author had to become compatible with the basic components, and achieve the correct conditions for the reactions; a situation that could only have been met by understanding the 'client system' and establishing suitable relationships within the system.

Thus the author's experiences in general lead him to support the general conclusions of the authors mentioned in this section; namely, that the problems of implementation deserve as much thought and attention from the researcher as his evaluation techniques, and the relationships developed between researcher and client play a vital part in successful implementation.

13.3.3. Staff-Line Relationships

The final area of the survey was an examination of literature relating to organisation and management of the project staff. Since the success rate of projects was high, similarities were sought between the approach adopted to project management and established theories of management practice.

All of the theories examined contained a strong element of participation by the individual, enhanced by McGregors theory Y hypothesis. Therefore a brief review of McGregors comments on theories X and Y follows.

McGregor (1960) - "one of the major tasks of management is the organisation of human effort in the service of the economic objectives of enterprise". A prime cause of failure in this task is a result of management attitudes that fail to recognise natural laws of human behaviour.

Theory X - the traditional view of 'Direction and Control' are the basis for the majority of management attitudes, and form the basis for classical organisational theory.

The theory is based on:

i. The idea that the average human being has an inherent dislike of work.

ii. Because of this dislike most people must be coerced, controlled, and directed into achieving organisational objectives.

iii. The average human prefers to be directed, wishes to avoid responsibility has very little ambition, and above all wants security.

However, McGregor sees man as a "wanting animal" for whom as soon as one need is satisfied another appears in its place. What theory X ignores or fails to recognise is that "a satisfied need is not a motivator of behaviour". The figure below indicates a hierarchy of needs, showing the need that will take the place of a satisfied need.

↑ Self fulfillment
Egoistic
Social
Safety
Physiological

The order of replacement of needs.

Theory Y recognises this hierarchy of needs and attempts to encourage satisfaction of the predominant need in a way that is compatible with achievement of organisational objectives.

Some of the main features of theory Y are therefore :

i. Expenditure of physical and mental effort in work is as natural as in rest or play.

ii. External control and threat of punishment are not the only methods for directing effort towards organisational objectives. Man will exercise self control in the service of objectives to which he is committed.

iii. Commitment to objectives is a function of the rewards associated with their achievement.

iv. The average human being learns to accept and seek responsibility under the proper conditions. To accept such a theory requires a high degree of participation of personnel at all levels, combined with the relinquishing of some of the control associated with traditional or classical organisations.

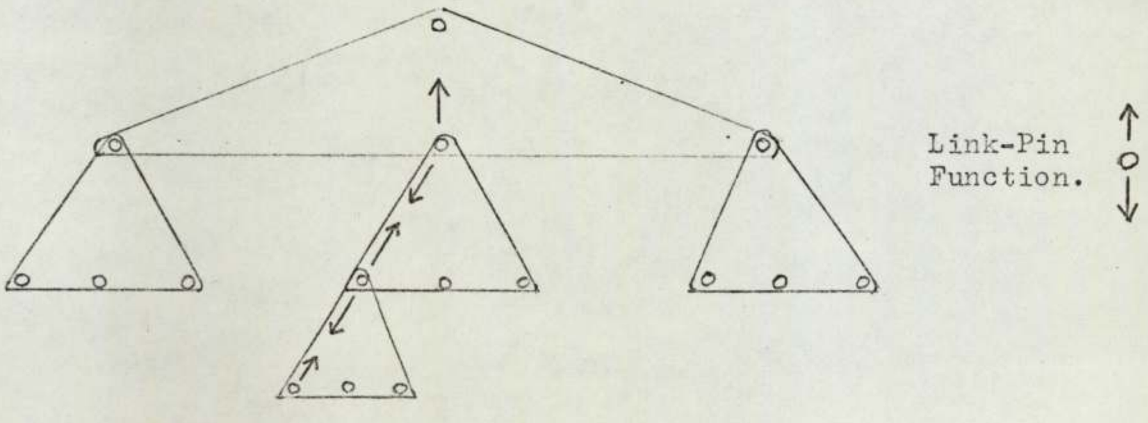
Likert (1961), as a result of studying patterns of management used by high producing managers in contrast to those used by other managers, proposed a new theory containing two important principles:

i. Integrating Principle - calling for interaction between members of the organisation, so that each feels appreciation, recognition, influence, and accomplishment.

ii. Principle of supportive relationships - "The leadership and other processes of the organisation, must be such as to ensure maximum probability that in all interactions and all relationships with the organisation, each member in the light of his own background, values and expectations, views the experience as supportive, and one which builds and maintains his sense of personal worth and importance".

This principle is also of great importance in the formation of his effective work groups within the organisation. Here he envisages a structure of overlapping work groups where responsibilities become less clearly defined than in the traditional structure, and work is seen more in terms of company objectives.

A further feature of this structure is the transfer of information and influence throughout the structure by the "Link-Pin function". As can be seen below the link-pin is a group leader at a particular level in the organisation.



Argyris (1967) on the other hand proposes a matrix organisation as a strategy to induce co-operation and integration of effort on crucial business problems.

By forming multi-disciplinary teams to solve particular problems, the organisational structure looks like a matrix e.g.

Representative	Project I	Project 2	Project 3
Production	/	/	
Engineering	/	/	/
Accountancy		/	
	Team I	Team 2	Team 3

However, to succeed such an organisation must escape from theory X types attitudes, by offering more power/control to individuals and/or groups, and increasing participation in diagnosis, design and execution of changes.

Finally, we have Management by Objectives M.B.O. as expounded by Drucker (1960), relating the individuals objectives to corporate objectives. Again this is an attempt to inject a strong element of participation into the system, seeking to increase motivation by achieving objectives by encouraging partidpation in setting objectives.

A theoretical appraisal by Wickens (1968), based on various models of human needs in an organisation, concludes that M.B.O. is universally acceptable, provided that the organisation is modified to facilitate it, and a suitable psychological model is used.

In retrospect the organisation and approach adopted for implementation of the project programme embodied features from most of the practices outlined above.

To beingwith, the effect of the programme in relation to overall departmental objectives was explained to all personnel involved in the programme. This provided the opportunity to appreciate the significance of individual projects in relation to the overall situation. i.e.

relating individuals assigned objectives to corporate objectives. Then project leaders were asked to co-ordinate the efforts of a multi-disciplinary team, and act as spokesman for the team. Also having discussed and understood the implications of their project, each project leader set his own targets for completion of the work.

Undoubtably, the fact that some project leaders were performing projects, which had arisen from their own ideas provided further personal motivation; but generally they welcomed the opportunity to be seen to be making a contribution to the department. So whilst it is impossible to conclude that the work in the Lockheed Department offers positive confirmation of validity of one of the theories mentioned, it does appear to conform with particular elements of each theory.

13.4. Conclusions

The concept of proof of theory is that it can be treated in a predictive form, e.g. if you treat situation A in manner B then C can be expected. It is of interest that much of the theoretical matter reviewed in the literature survey is hardly ever presented in a predictive form; this may well reflect the difficulty of obtaining hard evidence of conclusive proof.

The author's experiences should therefore be viewed in this light, and a statement that could be considered meaningful would be that those experiences do not refute the "theories" examined.

Therefore the decision to delay the survey can be supported by the fact that no one theoretical approach would have been directly relevant. There was no single 'magical' answer to the problem.

Chapter 14

Conclusions and Recommendations

In this chapter an attempt is made to review the conclusions that can be drawn from the project work, and then to make recommendations for further areas of work. The nature of research performed is such that conclusions and recommendations fall into two groups, i.e. those specifically related to the client (Dunlop) and those relating to general aspects of the work. The chapter is therefore divided into two sections covering these groups.
In the first chapter of the thesis, the major problems facing the company were identified as :

i. The urgent need to reduce the large losses being made in the Lockheed Department, which because the company could not close the department were threatening the factory's future.

ii. The expansion of business, provided a financially viable operation could be established and customer relations improved.

As has been shown, effort was concentrated on the loss problem; and the attempt to provide a solution to this problem was based on a combination of scientific method and common sense, in a simple sirect approach.

14.1. The Client

14.1.1. Conclusions (relating to the client)

1. As a specific attempt to reduce the financial loss found in the Lockheed Department in 1971, the project work aided the satisfactory solution to the problem.
2. Although no one specified approach was adopted during research, the approach to the problem consisted of a number of clearly defined stages, so the work could be summarised as follows :-

    1. Introduction - a period of familiarisation with, and the development of understanding of, the area in which research was to be conducted.

2. Problem Identification and The Definition of terms of reference for work - this followed directly from the first stage, and the terms of reference consisted of finding ways of reducing the departmental loss.

3. Generation of Ideas for Profit Improvement.

4. Evaluation of Ideas - the examination of arguments for and against each idea, and the collection of information for evaluation of each argument followed by evaluation.

5. Presentation - since the ideas had been produced and evaluated by an independent agent, they had to be submitted to management for approval prior to implementation.

6. Further Generation/Evaluation/Presentation of Ideas. - following the first presentation management accepted the validity of the approach and the results produced, and requested that it be extended to cover the most recent ideas for profit improvement prior to establishing an implementation programme.

7. Establishment of an Organisation for Implementation and Control of Profit Improvement Ideas - including selection of a Programme Co-ordinator and Project Team leaders, and ensuring that they understood the aims of the work.

8. Implementation of Ideas - performed by the organisation above with the authors guidance.

9. Evaluation of the Results of the Programme - an exercise to compare predicted savings with those actually obtained.

Expressing the approach in the above form indicates that much of the objectivity, and also the development of the stages, is derived from an experience of a scientific discipline and familiarity with scientific method . A scientific approach to problem solution would probably be composed of the following broad stages :

A. Data collection/observation
B. Hypothesis Generation
C. Predictions from hypothesis.
D. Testing of predictions.

E. Depending on the results of the tests -

i. The hypothesis would be acceptable or possibly refined in the light of the results, and stages C and D repeated

or ii. The hypothesis would be rejected and work would recommence at Stage A.

These stages appear to correspond to stages 1,2,3,4,8 and 9 of the approach used during research work.
Therefore the approach broadly follows the scientific method used in more traditional types of research project.

3. However, it is pertinent to ask whether the approach alone i.e. simply the rigorous application of objective rules based on scientific method, would be sufficient to ensure a successful solution to a similar problem situation.
There are two reasons for suggesting that it is not sufficient, namely :
i. Research in a live environment, where the researcher is faced with such constraints as shortage of time and lack of finances, produces important decision stages where the rules of scientific method cannot be applied in full. In such cases where it is not possible to adopt a scientific approach and test the various alternatives before making a decision, the researcher must be able to reach a decision in a rational manner.
Unlike the scientist who will be able to return to the decision point and recreate the "prevailing conditions" and adopt a second line of attack, the action researcher is not afforded such a luxury. His decision must be the right one, because invariably his "prevailing conditions" are unique and non reproducable. So it is not enough that he be diligent in the application of the approach; he must recognise the relative importance of decision points and be capable of reaching a rational decision without reliance on his accepted technique.

ii. Closely related to the above point; in so far as it is a direct result of a live environment, and therefore requires understanding and careful handling at decision stages and throughout the work; is the role of relationships between researcher and the clients. It is one thing to produce a correct solution to a problem, but the real test is to have it satisfactorily implemented by the client system.

Unfortunately, it must be said that simple rules cannot be added to the approach, which will ensure the generation of good relationships and the success of the work.
The nature of the environment, the work, the "clients" and the personal style of researcher will dictate the type of relationships that should evolve. The researcher must accept that they play an important role in "overall approach".
In the author's opinion then, an objective approach alone is unlikely to be sufficient to produce a satisfactory solution to a general problem of a similar type to that discussed in this thesis.

4. Indeed even the application of the basic rules of the approach is not as easy as it might appear.
Certainly all three company employees who attempted the approach in their own areas did not complete the work. There were extenuating circumstances in the form of the Power Crisis and 3 - day week, which caused considerable disruption. Even so, in spite of the fact they all understood the elements of approach, they seemed unwilling or unable to sustain the intellectual effort/discipline required for the work to succeed.
Therefore, as might be expected, practitioners of the approach to be successful must be capable of exerting the considerable self discipline that objectivity requires.

14.1.2. <u>Recommendations</u> (to the Client)
As the reader will appreciate many of the recommendations arising from the work have already been implemented. However, there are a limited number of points that can be directed at Dunlop, Skelmersdale.

1. Working from the assumption that the company should consider the possibility of repeating the type of exercise described in this thesis; then any decision should be taken in the light of the following points :-

   i. The indications that the manual on an approach to profit improvement, appears to have limited usefulness as a tool for existing personnel. The approach required personal qualities and motivation, which often cause conflict of various kinds. Further use of this manual by Skelmersdale personnel is of doubtful value.

ii. Therefore for repetition of project work at Skelmersdale, the obvious recommendation must be that the possibility of success with the project will be increased if performed by an independent agent, with the qualities described in general conclusions.

iii. It is more difficult to recommend a particular line of approach that such an agent should adopt, especially if in doing so it will infringe on his independence and objectivity! However, the broad outlines of the approach decribed in the profit improvement manual should offer sufficient guidance to achieve a sound understanding of the problem area, and to offer a framework for objective evaluation. Beyond this, the management of project must rest firmly in the hands of researcher.

2. The other area in which the company can benefit from the research performed, is that of understanding detailed reasons for change in the financial state of a particular area.
The manual on Gross Retrospective Analysis must be considered a useful tool. It is simple to use and can generate useful information. The fact that to-date the manual has not been used is not surprising, since this type of analysis is rarely attempted in an industrial environment.
However, the author's impression is that the manual and its application, possibly in a modified form, warrants further consideration by management.

14.2. The General Aspects of Project Work

The first half of this chapter has concentrated on comments directed at the company for whom the research was conducted. However, a number of remarks can be made, which do not relate directly to the client, but are of relevance to those who may consider a similar type of approach to a problem.

14.2.1. Conclusions

1. Mention was made in 14.1.1.(4) of the attempts of company employees to reproduce the approach, and their failure to do so. This failure does raise an important point, namely the position of the researcher in relation to the area of work. All the author's work was performed in the role of an independent agent,

and this independence is an undoubted aid in this type of work. All three employees faced a conflict of priorities, as they were expected to perform the research work in addition to their normal duties. Inevitably in such circumstances project work took second place to everyday problems.

The independent agent is not faced with such administrative problems, nor is he faced with additional problems of trying to prevent personal experience from colouring objectivity!

There is also the possible effect of the individual's motivation in the application of the approach. For the researcher it is likely that the overall success of project work will figure near the top of his motivational needs. However, an employee performing the work may well find that the work produces conflict with personal ambitions; either as a result of having to perform the work, or from the end product of the project.

So, it is extremely important that the researcher is an independent agent, in virtually all senses of the term.

2. The only area in which an agent should not be too independent is that of effective relationships with key personnel. He must use his independence to demonstrate complete objectivity and then develop his relationships from a base of political neutrality.
The likelyhood of overall success for an independent agent can be significantly increased if he devotes considerable time and effort to establishing effective relationships. The purpose of such relationships is not simply good communications, they provide a vital tool for work in a live environment.
The mere fact that an individual understands what is intended and required, is not always sufficient motivation. But a sense of involvement and positive contribution, developed through discussion and taking notice of individuals views, increases co-operation and the possibility of success. Also through developing relationships, the researcher is afforded the opportunity to assess the qualities of the individual, which may prove useful when considering the role the individual might play in implementation.

3. Finally, it would appear that a successful researcher in a live environment must be something of an enigma. He must be disciplined and objective in his use of the tools of his trade, adopting the position of an independent agent, whilst at the same time establishing the effective relationships mentioned above. If he is able to achieve such a state, he is most likely undergoing a degree of personal development not experienced in a traditional higher degree. Indeed, such development cannot be held as a prime reason for performing such work; but it certainly means that the researcher will be much better equipped for a future management role, than his counterpart in a 'traditional' scientific situation.

14.2.2. Recommendations

1. Any company/organisation in a position to support an independent agent, is likely to benefit from the services of such an individual. Invariably companies find problems that they have no time to solve in the detailed objective manner required. The independent agent is ideally suited to making a positive contribution in such areas.
2. Finally, this last point has possible implications for academic institutions. Certainly the approach adopted by the author is widely different from that which might be expected from a management student, or a research student from a business school university.

   If wider application of such an approach is to be considered by industry, then consideration should be given to the teaching and possible development of the approach by our academic institutions. The approach should warrant further attention for three reasons :

   i. It offers an apparently useful contribution to problem solving in a real environment.
   ii. Development of the approach can only serve to strengthen the ties between industry and the academic world.
   iii. Finally participation in the approach offers the researcher the opportunity for broader personal development, which must be considered as an important aspect of a sound education.

APPENDIX A

REPORT ON THE INITIAL STAGE I.H.D RESEARCH WORK IN THE LOCKHEED DEPARTMENT

CONTENTS :-

REPORT ON THE INITIAL STAGE OF THE I.H.D. SCHEME

RESEARCH WORK IN THE LOCKHEED DEPARTMENT

1. Aim of the report

This report is intended to provide the basis for decisions on the next area of work. These decisions can be made from the suggestions, many of which have been evaluated on a cash flow basis.

2. Content of the report

The report is composed of two main sections.

A. The evaluation of various hypotheses for cost savings in the Lockheed Department.

B. A summary of scrap costs in the department, illustrating the costs of material, labour and power wastages. This section also provides information for evaluating the hypotheses in section A.

Section A is subdivided into three sections, the contents of which are indicated below:-

I Hypotheses for cost savings, evaluation on a cash flow basis.

1. Replace Compression Moulds by Injection Moulds where possible.

2. Breakdown the Finishing Department into small units.

3. Reduce Compression moulding scrap costs, by regular inspection during moulding.

4. Replace 22 of the hand-lathes by 6 auto-lathes.

5. Improve the Inspection Area, and conditions in the Finishing Department.

6. Run the Edgwicks on a shorter cycle time.

7. Adopt a simple programme for Barwell production, to ensure continual stocks of compound for the Edgwicks.

8. Extend the twilight shift to run from 4.30p.m. - 10.30p.m.

9. Improve the use of information available to the production staff.

10. Eliminate the part finished stores.

11. Run the Edgwicks, Hydra moulds and Peco's on 3 shift male labour.

12. Reduce Injection Moulding scrap costs by regular inspection during moulding.

13. Reduce moulding costs by inspecting all parts after moulding.

Hypothesis Number	Total Estimated Saving	Total Cost of Implementation	Nett Saving
	£	£	£
1	39,137 p.a.	?	39,137 p.a.
2	27,678 p.a.	?	27,678 p.a.
3	31,327 p.a.	15,250 p.a.	16,077 p.a.
4	10,000 p.a.	11,760 p.a.	10,000 p.a.
5	9,000 p.a.	?	9,990 p.a.
6	9,400 p.a.	1,369 p.a.	8,031 p.a.
7	2,115 p.a.	190 p.a.	1,925 p.a.
8	4,720 p.a.	2,830 p.a.	1,890 p.a.
9	600 p.a.	Nil	600 p.a.
10	7,820 p.a.	7,820 p.a.	Nil
11	8,013 p.a.	9,786 p.a.	- 1,773 p.a.
12	5,467 p.a.	9,200 p.a.	- 3,733 p.a.
13	39,020 p.a.	66,600 p.a.	-27,580 p.a.

II Unevaluated hypotheses.

14. More careful mixing of compounds, to reduce the amount of compound rejected by the technical department.

15. Increase inspection or testing of mixed compound to eliminate any possibility of poorly mixed compound, and to provide information on optimum moulding conditions.

16. Provide equipment for finishing operat ors to check their own work.

17. Improve operator job responsibility and interest, by short lectures and explanations of the functions of parts.

18. Produce a production control system for the department capable of providing daily information on the exact situation of parts in the department. This could then provide a means to improve planning in the finishing department.

19. Use the computer facilities to produce compound mixing, moulding and finishing programmes.

III Suggestion for possible area of work:

20. A comparative evaluation of compression and injection moulding processes.

3. Recommendations

Hypothesis Number	Discard	Hold for Research later	Research Further	Implement
1			X	
2			X	
3			X	
4			X	
5			X	
6				X
7				X
8	X			
9				X
10	X			
11	X			
12	X			
13	X			
14		X		
15		X		
16		X		
17		X		
18			X	
19		X		
20			X	

3.1. Reasons for the various recommendations

3.1.1. Hypotheses Nos.1 - 5 offer the areas of greatest possible saving, with a combined total possible saving of £104,000 p.a. These evaluations are, however, incomplete, and therefore appear as possible areas for further work.

Hypotheses Nos.19 and 20 also offer possibilities for further research.

No.19 might involve production scheduling, which was Mr Pearson's (Graduate Liaison Officer) original idea for the project.

No.20 is the last possibility and has been suggested as valuable work for the company, by D. Air and A.A. Parr.

3.1.2. Hypotheses Nos. 6, 7 and 9 could be implemented after a little preparation. In fact, the Technical Department has been doing some work on idea No. 5.

3.1.3. Hypotheses Nos. 8, 10 - 13, can be discarded since only idea No.8 shows a gain and the idea is no longer applicable as the twilight shift is no longer worked.

3.1.4. The remaining ideas, in the main, are those which have not been evaluated and these could be retained for investigation at a later date.

1. Replace Compression Moulds by Injection Moulds - for those Compression Parts it is practical to mould by Injection Techniques.

ESTIMATED SAVING = £39,137 p.a.

NOTE:

The Planning Department has been examining the above idea. They have produced a list of approximately sixteen possible parts which would be suitable. Nine out of these sixteen appear on the scrap reports during the period in which the summary was made. Hence the summary figures have been used to evaluate this idea.

PROS

1. Reduction in the cost of production of good parts.

2. Reduction in the scrap levels, since scrap on Injection Moulding is less than on Compression Moulding.

Facts required:

1.0. Total number of good parts produced for the nine part numbers mentioned above

= 686,947 (in the 32 week period of the summary data).

1.1. Average number of good parts per part number

= 2,385 pr. week = 119,250 p.a.

IDEA NO. 1 - continued:

Facts Required: (continued)

1.2. Assuming that all sixteen parts are produced at this average rate - then the total number of good parts required per year

= 119,250 x 16 = 1,908,186 p.a.,

1.3. Savings made per good part by changing to Injection Moulding.

1.3.1. Average cost of labour, maintenance, and power in a good Compression part = £0.02965 (See Chapter 5 p).

1.3.2. Average cost of labour, maintenance and power in a good Injection part = £0.00914 (See Chapter 5 p).

1.3.3. The difference in average production costs = the saving per good part

= £0.02051 per part.

1.3.4. The assumption was made that the material cost will not change.

1.4. The savings on 1,908,186 good parts

= 1,908,186 x £0.02051

= £39,137 p.a.,

2. The reduction in scrap levels has been accounted for in the above evaluation. However, there might also be an improvement in the 'morale' of the department if the general scrap levels were to start falling, which in turn might have beneficial effects.

IDEA NO. 1 - continued:

CONS.

1. Lockheed (i.e., Automotive Products) might not agree to pay for new Injection Moulds to replace the present moulds.

2. Extra Edgwicks might be required.

Facts Required:

1. The Planning Department selected only those parts numbers with a sufficiently high monthly customer demand, to merit an Injection Mould, e.g., a minimum monthly call of 8,000 parts. Therefore, as the present moulds were due for replacement (in the majority of cases), it was anticipated that new injection moulds would be forthcoming.

2. The total number of extra Edgwicks required is nil.

2.1. The total number which will have to be produced to obtain 2,385 good parts per week

= 13,000 parts per month at a 27% scrap rate.

2.2. Assuming there are four parts per charge, and an average operator working the machine on a 60 second cycle can produce 40 charges per hour,

i.e., 4 x 40 = 160 parts per hour.

2.3. The time taken to produce 13,000 parts

= 81 hours = 4 days (working 2½ shifts).

IDEA NO. 1 - continued: CONS.

Facts Required: (continued)

2.4. Therefore, 16 part numbers would require 64 machine production days per month. Assuming 20 machine production days per month, then approximately 3 extra machines would be sufficient to provide the capacity. These machines were available, since at the time two machines were permanently shut down, and a further two were available but not 'commissioned'.

2. Breakdown the Finishing Department into Smaller Units

ESTIMATED SAVING = £27,678 p.a.,

PROS.

1. Reduction in cost of finishing scrap.

Facts Required:

1. Estimated cost of finishing scrap = £41,517 p.a. (from scrap summary).

1.1. Expected reduction in finishing scrap costs 2/3 (from results in the appendix below).

1.2. Possible saving £27,678 p.a.

IDEA NO. 2.-

Continued:

CONS.

1. Cost or reorganisation of the department.

*NOTE: The saving does not include a figure for reorganisation, as the cost would depend to a certain extent upon exactly how the department was organised.

Appendix to the above idea No.2.

This idea arose from a meeting between supervisors, at which mention was made of an experiment in the finishing department. In the experiment two parts were finished in isolatedunits, removed from the general finishing area.

1. Brief Summary of the Projects on Part Nos: 37374 & 87366

By mid 1971, the situation with regard to customer arrears on Part Nos: 37374 and 87366 was so serious that the whole production process was subjected to a thorough examination.

In order to examine and improve the finishing process, all the machinery and operators involved were placed in an isolated unit under one foreman. The foreman's responsibility was to improve the standard of work, and produce a sense of involvement in the project. He was aided in his work by the Production Engineering Department who improved the finishing machinery. Their combined efforts resulted in a marked improvement of scrap standards, as can be seen from the graphs.

IDEA NO. 2 - continued:

1. Brief Summary of the Project on Part Nos: 37374 & 87366: (cont)

The experiment was seen to be a success, and the situation with regards to customer demands solved. Then, as orders started to fall, the units were returned to the finishing department. As can be seen from the graphs, once the experimental conditions were removed, a gradual worsening of the scrap standards occurred.

2. Results of the Experiment

2.1. Deductions from the Graphs

2.1.1. Part No. 37374

(i) From the % Total Scrap Graph, making use of the trend curve, then:

a) The approximate scrap level before the experiment was ~150%.

b) During the experiment the level was reduced to ~27%.

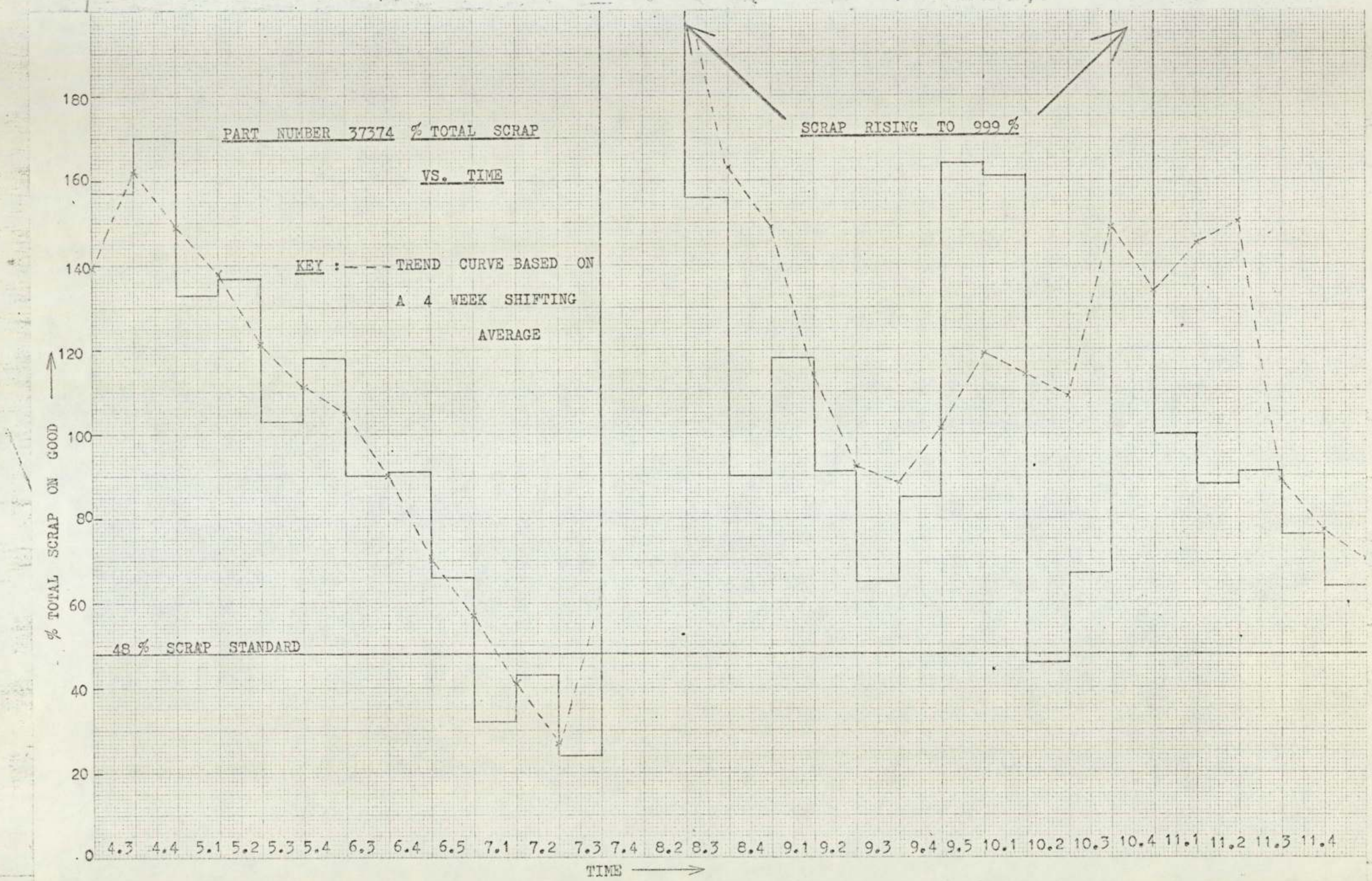
c) After the unit was returned to normal production, the scrap level rose, and appears to find a level at ~80%.

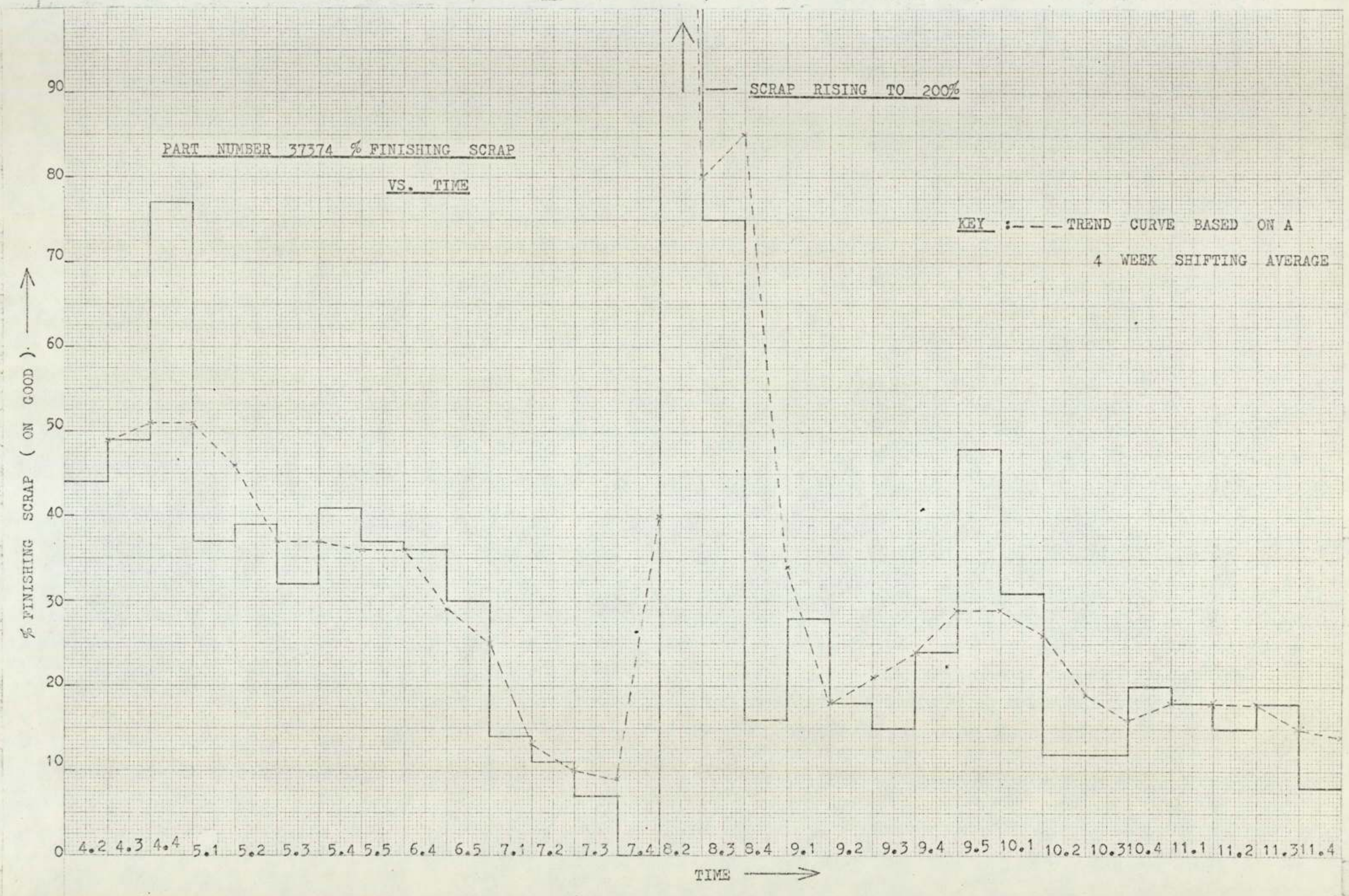
(ii) From the % Finished Scrap Graph, again making use of the trend curve:

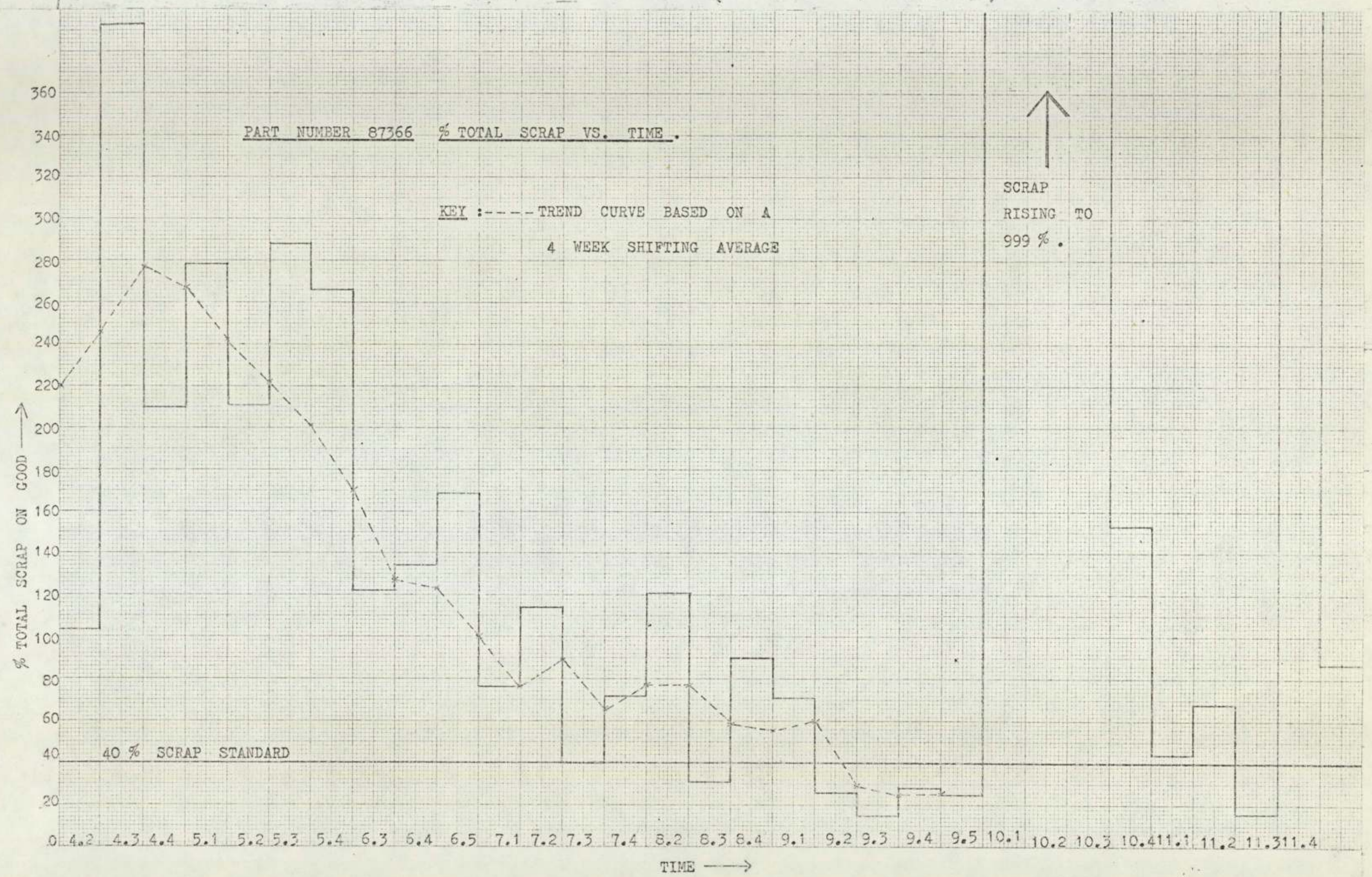
a) The approximate finishing scrap level before the experiment was ~50%.

b) During the experiment finishing scrap was reduced to ~8%

c) After the unit was returned to normal


PART NUMBER 37374 % TOTAL SCRAP
VS. TIME
KEY : - - - TREND CURVE BASED ON
A 4 WEEK SHIFTING
AVERAGE
SCRAP RISING TO 999 %
48 % SCRAP STANDARD
% TOTAL SCRAP ON GOOD
180
160
140
120
100
80
60
40
20
0
4.3 4.4 5.1 5.2 5.3 5.4 6.3 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3 11.4
TIME


PART NUMBER 37374 % FINISHING SCRAP
VS. TIME
SCRAP RISING TO 200%
KEY :- - - TREND CURVE BASED ON A
4 WEEK SHIFTING AVERAGE
% FINISHING SCRAP (ON GOOD)
TIME
0
10
20
30
40
50
60
70
80
90
4.2 4.3 4.4 5.1 5.2 5.3 5.4 5.5 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3 11.4



PART NUMBER 87366 % TOTAL SCRAP VS. TIME.
KEY : ---- TREND CURVE BASED ON A 4 WEEK SHIFTING AVERAGE
SCRAP RISING TO 999 %.
40 % SCRAP STANDARD
% TOTAL SCRAP ON GOOD
TIME
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
4.2
4.3
4.4
5.1
5.2
5.3
5.4
6.3
6.4
6.5
7.1
7.2
7.3
7.4
8.2
8.3
8.4
9.1
9.2
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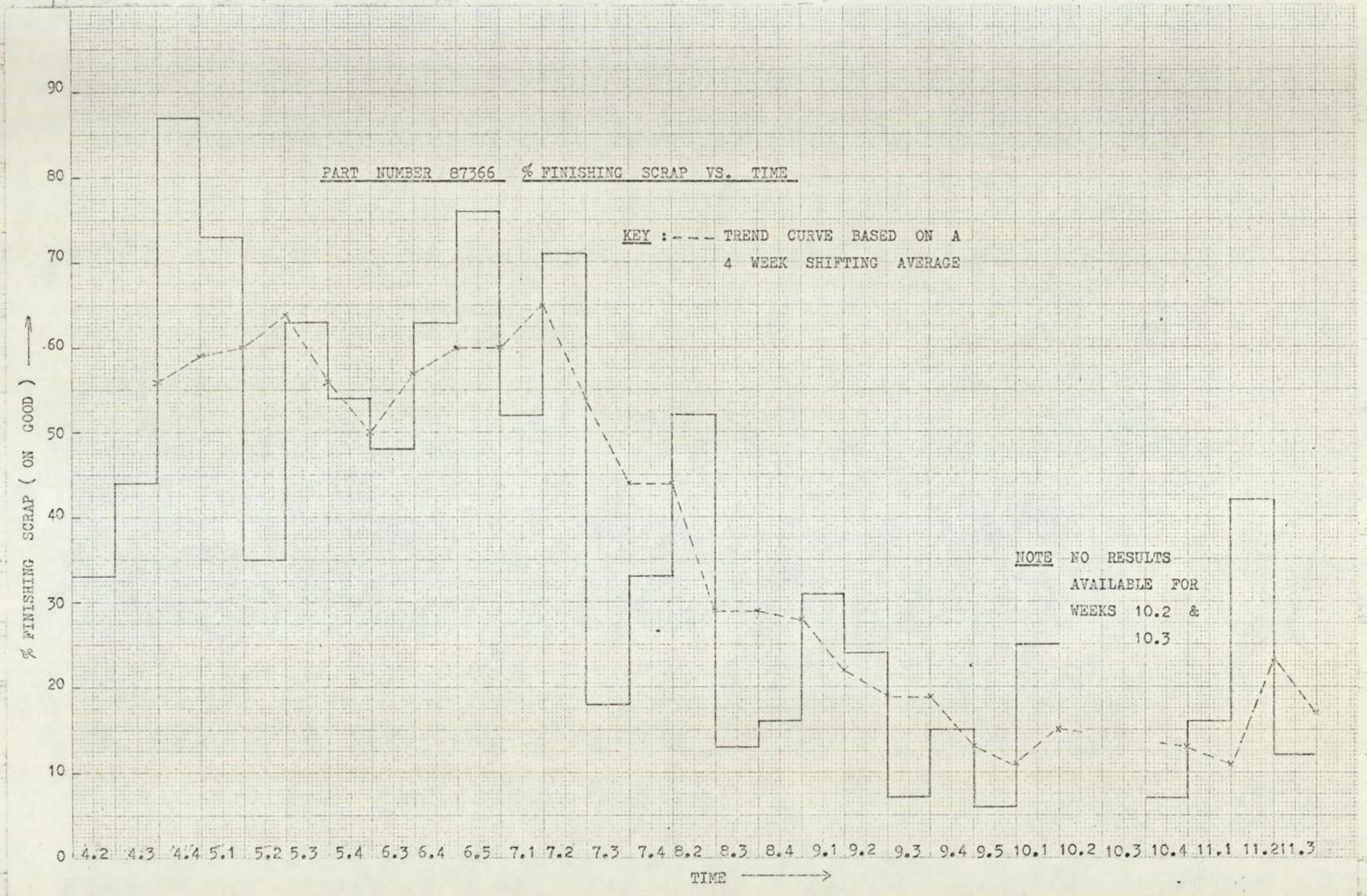
10.4
11.1
11.2
11.3
11.4



PART NUMBER 87366 % FINISHING SCRAP VS. TIME
KEY : - - - TREND CURVE BASED ON A 4 WEEK SHIFTING AVERAGE
NOTE NO RESULTS AVAILABLE FOR WEEKS 10.2 & 10.3
% FINISHING SCRAP (ON GOOD) ⟶
0
10
20
30
40
50
60
70
80
90
4.2 4.3 4.4 5.1 5.2 5.3 5.4 6.3 6.4 6.5 7.1 7.2 7.3 7.4 8.2 8.3 8.4 9.1 9.2 9.3 9.4 9.5 10.1 10.2 10.3 10.4 11.1 11.2 11.3
TIME ⟶

IDEA NO. 2 - continued:

2. Results of the Experiment: (continued)

2.1.2. Part No. 87366

Apply the same method as above.

2.1.3. We can now tabulate the results in the following manner:

Part Nos:	37374		87366	
	% Total Scrap.	% Fin Scrap.	% Total Scrap.	% Fin Scrap.
Before exp't.	150%	50%	255%	57%
During exp't.	27%(min)	8%(min)	80%	30%
After exp't.	80%	15%	70%*	18%

* Very difficult to estimate the level of scrap, but the figure quoted is the average of the last four sets of figures.

2.1.4. Conclusion from results

2.1.4.1. For Part No. 37374, the experiment reduced total scrap by ½ and the finishing scrap by 2/3. However, if experimental conditions could have been maintained, the reductions on the original values could have been 5/6.

2.1.4.2. Interpretation of results for Part No. 87366 was not so straightforward. The trend for the scrap figures continued downwards after the experiment had finished (the experiment ended shortly after the factory's annual shutdown).

However, the results indicate that the experiment achieved a reduction of 2/3 on both Total and

IDEA NO. 2 - continued:

3. Determination of the reasons for success

Possible reasons for success:

3.1. Improvement in machinery.

3.2. Greater operator involvement in production standards and the production team.

3.3. Increased supervision.

3.4. The interest of the factory manager.

It is, however, almost impossible to quantify the contributions made by the above factors, from the available data.

4. Conclusions

The implementation of any comparable situation on the finishing end as a whole is only likely to be successful if the same experimental conditions are obtained.

An attempt to use the isolation idea has been made, by the erection of wooden partitions. However, since these are only 5 ft. high, the department does not appear to be divided into sections.

This apparent lack of isolation, combined with the lack of intensive supervision is the probable reason for the fact that finishing scrap has not been significantly reduced.

So, if the idea is to be implemented more work should be done to define the optimum operating conditions.

3. **Reduce Compression Moulding Scrap Costs by regular inspection of parts during moulding.**

ESTIMATED SAVING = £16,077 p.a.

NOTE: The inspection section would ensure that all the finishing is done on the samples taken, so that all types of moulding scrap could be detected.

PROS.

1. Reduction in the cost of compression moulding scrap.

Facts Required:

1.1.1. Cost of compression moulding scrap (from section B)

= £55,342 p.a. (excluding maintenance).

1.1.2. Possible saving in costs due to the inspection suggested in the 'cons' - 40% (- estimated by the senior moulding foreman).

Saving = £22,137 p.a.(for 40% reduction in scrap)

1.2.1. Cost of maintenance in compression moulding scrap

= £22,980 p.a.

1.2.2. Possible saving in costs due to reduction in quality produced by inspection.

Saving = £9,190 p.a.(for 40% reduction)

IDEA NO. 3 - continued:

CONS.

1. Extra Inspectors would be required to inspect the compression samples.

Facts Required:

1.0. Cost of inspection labour for compression moulding.

1.1. The Senior Foreman estimated that three inspectors per shift could reduce the moulding scrap by 40%.

1.2. The cost of employing three inspectors per shift, for 3 shifts, assuming the inspectors to be paid at the top grade.

These costs are estimated at:

9M x 40 hours @ £0.74 per hour + shift allowance for 3 shift working x 52 weeks

= £15,250 p.a. = Total Cost of Idea

Giving a net estimated saving = £16,077 p.a.

4. Replace 22 of the present hand-lathes by 6 auto lathes.

Estimated Saving = £10,000 p.a. (after the first 15 mths).

PROS.

1. Reduction of total labour force, since one operator can work 3 auto-lathes. Therefore, a saving in labour costs can be made.

2. By employing male labour, the auto-lathes can be operated on a 3 shift system.

IDEA NO. 4 - continued:

Facts Required:

1.1. Output from the hand lathes averages 71,000 parts per day from 26 lathes i.e., 2700 parts per 8 hours/per machine.

1.2. Output from the auto lathes averages ~50,000 parts per 24 hours from 6 lathes (working $2\frac{1}{2}$ shifts) i.e., 3,300 parts per 8 hours/per machine.

1.3. ∴ 6 auto lathes operating 3 full eight hour shifts per day would cut ~59,400 parts, which is equivalent to

$$\frac{59,400}{2,700} = \text{The output from 22 hand lathes}$$

1.4.1. Saving of labour cost of 22 female lathe operators = £20,030 p.a.

1.4.2. However, the cost of 6 males working 3 shifts = £10,020 p.a.

1.4.3. Therefore, we have an estimated net labour cost saving of £10,010 p.a.,

NOTE: (1.4.2. Has not be included as a 'con' in this idea because in this case all the 'cons' are 'one-off' capital cost expenses, and the two expenses have not been mixed to avoid misunderstanding).

Pro. 2. has already been used in the above evaluation see 1.3.

IDEA NO. 4 - continued:

CONS.

1. Cost of machinery and installation.

2. Limitations of the type of parts suitable for using on auto-lathes.

3. Training cost of setter-operators.

4. Setting Times.

Facts Required:

1.1. Cost of 1 auto-lathe including installation = £1,500 (figure from the Assistant Departmental Manager who had been responsible for the purchase of those 'autos' in use).

1.2. Cost of 6 auto-lathes = £9,000

2. Limitations to the type of parts used on the present auto-lathe, arose from the fact parts were held in the chuck by vacuum. This meant that those parts designed with holes in them were unsuitable for this type of machine. However, there were in use at the Girling factory a mechanical type of auto-lathe, which would accept most type of parts. It was therefore, recognised that before any transfer could take place an investigation was required as to the type of machine required. This information was obtained from the finishing foreman whose 'anti' views were of considerable importance.

IDEA NO. 4 - continued:

Facts Required: (cont)

3.1. Training a setter operator was generally expected to take 10 - 18 weeks (estimated by the Training Department).

3.2. Thus the cost of training was estimated as

6 x 14 weeks wages per operator = £2,760

4. Again discussion with the finishing foreman produced an important point, that of 'setting up times'.

4.1. Hand lathe setting up time = 6 - 15 minutes.

4.2. Auto lathe setting up time = 15 - 60 minutes.

This was because with the automatic machine not only the chuck had to be changed, but also parts of the automatic feeding mechanism. Thus provision would have to be made to ensure that auto-lathes would 'run' for a sufficient time, to justify the time spent 'setting up' the machine.

∴ Total Estimated Capital Cost = £11,760.

5. Improvement of inspection area, and investigation into the ideal conditions for the finishing department as a whole.

ESTIMATED SAVING = £9,990 p.a. (for a 15% increase in output).

This idea was formed as a result of a visit to the No. 1 factory and seeing the contrast in general conditions with the Lockheed Department, e.g. the inspection area in the No. 1 factory is completely detached from the general production area, housedin a separate room. This is not the case in the Lockheed Department, where the inspectors are subjected to many more distractions, in the form of passing people and noise.

Furthermore, the lighting in the Lockheed Department appears almost dim in comparison with the No. 1 factory.

The main suggestion would, therefore, be: the isolation of the inspectors from the general production area.

PROS.

1. Increase in inspection rates, hence a reduction in labour costs for the same total output.

Facts Required:

1. Increase in inspector's output 15% - guess from the Dept. Manager.

1.1. Therefore, for the guess we have a 15% saving in labour costs.

1.2. Labour costs of inspection - £66,600 pa.

Therefore, for a 15% increase in output the saving is £9,990 p.a.

(Similarly the savings for 10% and 20% increases would be £6,600 p.a. and £13,200 p.a).

IDEA NO. 5 - continued:

CONS.

1. *Against the saving must be weighed the cost of isolating the inspectors, and generally improving inspection conditions.

6. Run the Edgwicks on a shorter cycle time (e.g. 20% shorter) Therefore improving output capacity.

ESTIMATED SAVING = £8,031 pa.

PROS.

1. Greater production for the same labour input; or the same total output for reduced labour input.

Facts Required:

1. Same total output for a reduced labour input.

1.1.	Number of Edgwicks in use	-	17
1.2.2.	Number of operators	-	39 (3 x 13)
1.2.2.	Number of setters	-	9 (3 x 3)
1.3.1.	Cost of operator	-	£1,200 p.a.
1.3.2.	Cost of operator labour	-	£47,00 p.a.
1.3.3.	Cost of 1 setter	-	£1,900 p.a.
1.3.4.	Cost of setting labour	-	£17,000 p.a.

1.4. Possible decrease in labour force by 20%

Saving only likely on operators, still likely to require 3 setters per shift.

IDEA NO. 6 - continued:

PROS.

Facts Required: (cont)

1.5. Potential saving £9,400 p.a.

or if from Con.1 the saving is reduced by 20% saving £7,520 p.a.

Potential saving		£9,400	Pro. 1.5.
or reduced saving		£7,520	Con. 1.
Costs		£1,369	Cons. 2.3, 2.6,
Net saving	=	£6,151 p.a.	
or	=	£8,031 p.a. if we assume 100% effective labour redeployment.	

CONS.

1. Difficutly of effective redeployment of labour.

2. Possible increase in maintenance costs.

3. Union will require the jobs to be re-rated.

4. Possible constraint in the area of mould cleaning, can the present labour force cope effectively with the increased rate.

5. Reduction of mould life.

6. Will require greater operator attention and efficiency, question whether present labour is suitable.

IDEA NO. 6 - continued:

CONS.

Facts Required:

1. Difficulty of effective labour redeployment. Estimate only 80% effective.

2. Maintenance cost increases. It is likely that the maintenance cost per machine will rise, but the overall increase will be small.

2.1. Cost of Edgwicks plant maintenance -

Found from total annual plant maintenace £99,000 p.a. (from costing sheets).

Figures from the Engineering Department show that division of costs are:

62% compression, 22% Edgwicks, 16% rest.

2.2. Therefore, estimated cost of Edgwick maintance is £21,780.

2.3. Thus an increase of 5% would cost £1,089 p.a.

2.4. Cost of mould maintenance, found in an idential manner to plant maintenance -

Total annual costs £21,600 p.a.

Division of costs:

66% compression, 26% Edgwicks, 8% rest.

2.5. Cost of Edgwick mould maintenance £5,590 p.a.

2.6. Thus an increase of 5% would cost £280 p.a.

IDEA NO. 6 - continued:

CONS.

Facts Required: (cont)

3. Jobs would require re-rating for incentive schemes.

4. Present labour force could cope with the increased rate.

5. Reduction of mould life, unimportant since moulds supplied by Lockheed.

7. By the adoption of a simple programme for Barwell Production, ensure continual stocks of compound for the Edgwicks.

ESTIMATED SAVING = £1,925 p.a.,

The programme could be based on present stock levels, and future requirements. It would be produced by either the shift foreman, or the Barwell operator.

PROS.

1. Eliminate lost production time on the Edgwicks due to no compound.

2. Saving on incentive scheme now in use, by ensuring better utilisation of machinery.

Facts Required:

1. Downtime on the Edgwicks, found to be 90 hours per week (from monitoring sheets).

1.1. Cost of lost production on Edgwicks.

1.1.1. Operator labour cost ($\frac{1}{2}$ the average operator labour cost, since the operator continues to man one machine) = 32p. per hour.

IDEA NO. 7 - continued:

PROS.

Facts Required: (cont)

1.1.2. Machine depreciation 10p per hour (as in Idea No. 11).

1.1.3. Extras; heating, power, etc., ~5p per hour.

1.1.4. Total cost of downtime per hour ~47p.

1.2. Possible saving by the elimination of downtime = £2,115 p.a.

CONS.

1. The idea requires extra material in stock.

2. The fact that somebody would have to be trained to produce the programme.

Facts Required:

1. Present annual materials costs for Edgwicks estimated - £47,000 pa

1.1. The programme idea would involve, in theory, the holding of an extra day's stock. Effectively over the period of a year one extra day's stock would be required.

1.2. Cost af an extra day's stock ~£190 p.a.

2. Cost of training operative to produce the programme, providing the programme is as simple as possible, training costs should be very small.

Thus, we have a net estimated saving = £1,925 p.a.,

IDEA NO. 7 - continued:

CONS.

Facts Required:

However, this idea had been produced while working with one foreman on shifts, and my appraisal of the situation may have, to some extent, been affected by his opinions.

On questioning the senior foreman on the position, he informed me that, in fact, the department is theoretically in a position to over produce on compound requirements.

He informs me that the compound shortage is due to machine trouble on the Barwell.

NOTE:

I feel that the introduction of some type of programming of stock requirements, would be of use, if only to produce better stock control.

8. Extend the twilight shift to run from 4.30 p.m. - 10.30 p.m. (on female labour)

ESTIMATED SAVING = £1,890 p.a.,

PROS.

1. Eliminate approximately 165 hours lost production time per week.

2. Eliminate 2/3 of the 5% unrecorded scrap production on the Edgwicks, caused by shutdown between shifts. (In this case between day and twilight and night shifts).

IDEA NO. 8 - continued:

PROS.

3. Reduction of the labour force for the same total output.

Facts Required:

The arguments are identical to those quoted in Idea 11. Hence the working has been reduced to a minimum.

1. Estimated saving in elimination of downtime £1,240 p.a.

2. Saving of 2/3 of 5% unrecorded Edgwick scrap £3,480 p.a.

3.1. Lost production time = 165 hours per week.

3.2. Lost scrap in Edgwick scrap production = 2/3 of 108 hours
= 72 hours.

3.3. Therefore, 8% of production is lost.

3.4. Then assuming that labour redeployment 100% effective, the estimated reduction in labour is 8%.

Total estimated saving is = £1,240 + £3,480 = £4,720 p.a.

CONS.

1. Increased cost of labour due to lengthening the shift.

2. Increased costs of maintenance and material.

3. Difficulty of effective redeployment of any surplus labour (same as Cons. in Idea 11).

IDEA NO. 8 - continued:

CONS.

Facts Required:

(Sames as Pros).

1.1. Cost of labour in the present situation:

Edgwicks	£45,000 p.a.
Hydramolds	£ 6,000 p.a.
Nat.Ins.	£ 4,100 p.a.
TOTAL	£55,100 p.a.

1.2. Cost of labour for extended shift:

Edgwicks	£46,760 p.a.
Hydramolds	£ 6,240 p.a.
Nat.Ins.	£ 4,100 p.a.
TOTAL	£57,100 p.a.

1.3. Increase in costs = £2,000 p.a.

2.1. Increases in material and scrap cost - nil. Since same output maintained.

2.2. Increase in maintenance costs on an increased machine usage of 8% = £610 p.a.

2.3. Increase in mould maintenance on same basis = £220 p.a.

Therefore, total cost = £2,830 p.a.

Total estimated net saving = £4,720 p.a. - £2,830 p.a.

= £1,890 p.a.

9. More effective use of information available by the production staff.

e.g. 1. The use of information obtained by the technical department from the testing of batches after mixing, by the moulding foreman.

This could be achieved in a number of ways:

(i) The technical department could issue a weekly report containing the results of tests for each batch, and indicate where trouble might be expected.

(ii) The relevant information might be noted on the compound batch cards, so the required information would be immediately available to the moulding foreman.

ESTIMATED SAVING = £600 p.a.

PROS.

1. Eliminate wasted production time due to poor compound.

2. Saving on material wasted in production of scrap due to poor compound.

Facts Required:

1. Estimated lost production time (on Edgwicks) 2 or 3 hours per day. (Guess by two moulding foremen).
Therefore, estimated lost production time per week =
12 hours ($2\frac{1}{2}$ x 5).

1.1. Value of lost production time = downtime value i.e., 47p/hour.

IDEA NO. 9 - continued:

PROS.

Facts Required: (cont)

1.2. Total value of lost production time $= 12\frac{1}{2} \times 50 \times$ £0.49p.a.

$=$ £290 p.a.

2. Material wasted in $12\frac{1}{2}$ hours out of $17 \times 21 \times 5$ Edgwick production hrs.

2.1. Time spent in producting scrap parts due to poor compound is:

$\frac{12\frac{1}{2}}{1785}$ i.e., 0.7% of the total time.

2.2. Therefore, assuming that 0.7% of the material is wasted.

2.3. Total materials consumption on Edgwicks £44,400 p.a.

2.4. Value wasted material = £310 p.a.

Therefore, estimated total saving = £600 p.a.

CONS.

1. The foreman may not be able to use the information correctly.

Opinion of Senior Foreman:

Of the three present moulding foremen two would be capable of using the information without any training, the third one would not. He suggested that the idea might in time be continued, so that the setters would be in a position to use the information. The setters would, of course, require some training, although they would tend to learn from experience.

IDEA NO. 9 - continued:

e.g. 2. More effective use of the weekly scrap report by the foreman, i.e. using previous results to anticipate where trouble is likely to arise.

This could be done by checking the coming week's moulding programme against the accumulative figures on the scrap report. In this way, the foreman could see which parts have been produced at high moulding scrap rates.

Alternatively, this information could be included in the moulding programme when it is produced.

PROS.

1. Anticipation of high moulding scrap parts, and possible reductions of scrap levels by more operator and foreman attention.

10. Eliminate the 'Part-finished stores and storeman'

ESTIMATED SAVING = nil.

The idea was that 'Part-finished stores' should be removed from the department. As it turned out it was a rather poor idea as discussions with 'interested parties' were to indicate, as the 'function' could not be eliminated.

PROS.

1. Eliminate the labour cost of storemen.

IDEA NO. 10 - continued:

PROS.

2. Possible income from renting outthe stores area to another department.

3. Possible reduction in Lockheed Department's rates, as a result of reducing the floor space used.

Facts Required:

1. Cost of part finished storemen
   = £6,720 p.a. (From Labour Scrap Model).

2. The use of the stores area was limited, because it was in the centre of the general production area of the department. Hence it was unlikely that any other department would want to rent the area.

3.1. The sq.footage of the stores = 2,300 sq.ft.

3.2. The rates paid = 5p./sq.ft.

3.3. Potential Saving = £1,150 p.a.

CONS

As was mentioned in Chapter 4, this idea was discussed with three members of the departmental staff and the industrial engineering department, and they came up with the follwoing arguments against

IDEA NO. 10 - continued:

CONS.

1. The part finished stores is a check stage in the production process. The moulding operator's work is counted, and the information used by the wages section to compile the wages. Thus, if the stores were eliminated then either:

   A. Labour would be required to check the operators' work

   or

   B. The wages system would have to be altered.

2. The stores provides an area in which parts can be kept between stages of production. Thus, unless part finished stocks are reduced, this area is required for storage.

Conclusion:

Because of the ramifications of a change in the wages system it was assumed that the labour required in checking the operators work claims would not be less than already employed. Also since the storage area is required somewhere within the department it is unlikely that any saving would be obtained from 'Pros' 2 and 3. Hence the estimated saving from the idea was nil.

11. Run the Edgwicks, Hydramolds and Peco's on 3 shift male labour.

ESTIMATED SAVING = £1,773 p.a. (LOSS)

PROS.

1. Eliminate the present situation of approximately 375 hours lost production per week.

IDEA NO. 11 - continued:

PROS.

2. Eliminate the 5% unrecorded scrap production on the Edgwicks, caused by the shut down between shifts.

3. Reduction of labour force for the same total output.

Facts Required:

1. Value of downtime, i.e. lost production. The department has been assigning a value of £6.6 per hour, based on sales lost through machine stoppage. In an ideal situation where everything produced is sold this is a reasonable value. However, in the department, a quantity is produced in accord with customer requirement. Thus, providing orders are met, this value of downtime is not £6.6 per hour.

Estimated cost of downtime

1.1. Operating labour - nil. Since no operators employed during this period.

1.2. Machine depreciation 10p (calculated from machine cost (Edgwick) £5,000 written off over ten years.

1.3. Extra heating, steam, light, etc., 5p per hour. Therefore, total cost 15p per hour.

Therefore saving a) £124,00 p.a. using £6.6 per hour

b) £ 2,813 p.a. using 15p per hour.

IDEA NO. 11 - continued:

PROS.

Facts Required: (cont)

2. Value of the 5% unrecorded scrap on the Edgwicks (figures from the summary on scrap).

2.1.	Cost of materials	£2,300 p.a.
2.2.	Cost of labour	£2,600 p.a.
2.3.	Cost of sheet rubber	£ 300 p.a.
	TOTAL	= £5,200 p.a.

3. Reduction of the labour force for the same total output.

3.1. Lost production time 375 hours per week.

3.2. Total production time 3,000 hours per week.

3.3. Lost or scrap production time on the Edgwicks is 5%.

3.4. Total production time on Edgwick = 18 x 5 x 24 hours = 2,160 hours.

3.5. Lost time in Edgwick Scrap production = 5% of 2,160 = 108 hrs/wk.

3.6. Total lost or wasted production time = 375 + 108 = 483 hours.

3.7. Therefore, approximately 16% of production time is lost.

3.8. Therefore, estimated reduction in labour approximately 16%

3.9. Assuming that labour redeployment is 100% effective, then estimated reduction in labour is 16%.

Thus, total estimated saving is: £2,813 + £5,200 = £8,013 p.a.

IDEA NO. 11 - continued:

CONS.

1. Increased cost of male labour, plus shift allowances.

2. Feeling in certain quarters that female labour is preferable to male labour.

3. Increased cost of maintenance and materials.

4. Difficulty of effective redeployment of labour.

Facts Required:

1.1. Cost of labour for the present situation.

1.1.1. Edgwicks £45,000 p.a.

1.1.2. Hydramolds £6,000 p.a.

1.1.3. Peco's £4,100 p.a.

1.1.4. Nat.Ins. (+ Insurance) £4,100 p.a.

TOTAL = £57,600 p.a.

1.2. Cost of labour for 3 shift male labour.

1.2.1. Edgwicks £60,000 p.a.

1.2.2. Hydramolds £8,900 p.a.

1.2.3. Peco's £4,450 p.a.

1.2.4. Nat.Ins. (+Insurance) £5,360 p.a.

TOTAL = £78,710 p.a.

IDEA NO. 11 - continued:

CONS

Facts Required: (cont)

1.2.5. From Pros. 3.9. we can reduce this cost by 16%.

1.2.6. Therefore, cost of 3 shift male labour = £66,116 p.a.

1.3. Increase labour costs = £66,116 - £57,600 p.a.

= £ 8,516

3.1. Increased materials costs - nil, since the total labour output is the same.

3.2. Increased maintenance costs for machinery, increase is likely to be very small, since the total number of machines can be reduced, while maintaining the same output. Increased machine usage 12%.

3.2.1. Maintenance costs estimated as in Idea 6.

Edgwicks	£21,780 p.a.	
Hydramolds	£ 6,100 p.a.	(Average Hydramold requires less maintenance than Edgwick - foreman guess)
Peco	£ 3,000 p.a.	
TOTAL =	£31,380 p.a.	

3.2.2. Thus, if maintenance costs overall increase by 3%, the increased costs are £940 p.a.

IDEA NO. 11 - continued:

CONS.

Facts Required: (cont)

3.3. Similarly for mould maintenance using same figurs as in Idea 6.

3.3.1. Estimated mould maintenance costs £11,000 p.a.

3.3.2. Thus, if maintenance costs increase by 3% overall, the increase in costs is £330 p.a.

4. There will be no increase in scrap production since the output is maintained.

5. Difficulty of effective labour redeployment, assume as in Idea 6, only 80%.

Thus total estimated cost of introduction of 3 shift male labour is

= £8,516 + £940 + £330.

Total cost = £9,786 p.a.

NOTE:

(Con. 2. referring to the desirability of female labour is a subjective argument and not suitable for financial evaluation).

12. Reduce Injection Moulding scrap costs by regular inspection during moulding.

ESTIMATED SAVING = £3,733 p.a. (LOSS)

PROS.

IDEA NO. 12 - continued:

PROS

Facts Required:

1.1.1. Cost of injection moulding scrap (from scrap summary) = £47,274 p.a

1.1.2. Possible saving in costs due to inspection suggested in the 'cons' - 10% guess by the Senior Foreman.

Saving = £4,727 p.a. for 10%

= £2,364 p.a. for 5%

= £7,090 p.a. for 15%

1.2.1. Cost of mainteance in Injection Moulding scrap = £7,400 p.a.

1.2.2. Possible savings in maintenance costs are:

Saving = £ 740 p.a. for 10%

= £ 370 p.a. for 5%

= £1,110 p.a. for 15%

Therefore, total saving = £5,467 p.a. for 10% reduction in scrap.

= £3,134 p.a. for 5%

= £8,200 p.a. for 15%

CONS

1. Extra inspectors would be required to inspect the Injection samples.

Facts Required:

1. Cost of inspection labour.

IDEA NO. 12 - continued:

CONS.

Facts Required:

1.1. The Senior Foreman estimated that two inspectors per day and twilight shift and three per night shift, could reduce the moulding scrap by 10%. Only two inspectors would be required on day shifts because the finishing end would be working and they could perform the finishing and inspection operations.

1.2. Cost of the extra inspectors.

2M x 40 hours @ £0.74

2F x 22½ hours @ £0.45

3M x 40 hours @ £0.74 + shift allowance for working permanent night shifts

= £9,200 p.a.,

Therefore, even with a 15% reduction in scrap the idea would still show a loss.

13. Reduce moulding costs, by inspecting all parts after moulding, and before any finishing is performed.

ESTIMATED SAVING = £27,580 p.a. (LOSS)

PROS.

1. Reduction in the costs of finishing labour wasted on finishing moulding scrap.

IDEA NO. 13 - continued:

PROS

2. Reduction of moulding scrap reaching the finishing and inspection departments, may have beneficial effects on operator morale. This in turn could benefit production rates and standards.

Facts Required:

1.1. Labour costs of finishing moulding scrap (figures taken from scrap summary).

1.1.1. Labour cost of finishing compression moulding scrap £14,800 pa.

1.1.2. Labour cost of finishing injection moulding scrap £13,350 p.a.

1.1.3. Total cost of finishing moulding scrap = £28,150 p.a.

1.2. Labour cost of inspecting moulding scrap.

1.2.1. Labour cost of inspecting compression moulding scrap £5,620.

1.2.2. Labour cost of inspecting injection moulding scrap £5,250 p.a.

1.2.3. Total cost of inspecting moulding scrap = £10,870 p.a.

1.3. Total cost of finishing and inspecting moulding scrap = £39,020 pa.

Therefore, total estimated saving = £39,020 p.a.

2. This is the type of 'Pro' which cannot be assigned a financial value.

IDEA NO. 13 - continued:

CONS.

1. Extra inspectors would be required to inspect the parts after moulding.

2. Possible difficulty of siting the inspection area.

Facts Required:

1. Required labour for 100% inspection.

1.1. Total number of parts to be inspected is equal to the number of parts now being inspected after finishing. Therefore, it was assumed that a labour force equal to the existing inspection section would be required.

1.2. Present cost of inspection labour (figure from the scrap summary) = £66,600 p.a.

1.3. Total costing inspection = £66,600 p.a.

(In view of the size of estimated loss resulting from the above above argument no estimates were made as to possible costs of siting such an area).

2. NOTE:

There is also a possibility that this inspection can be performed by the operator on the machine. It is hoped to cover this possibility in a later idea. This would involve the consideration of:

IDEA NO. 13 - continued:

2. NOTE: (cont)

i) Training the operators.

ii) Whether the number of machine operators have under their control, would have to be reduced to obtain the required degree of inspection. Furthermore, whether such a situation is an economic proposition. Also the fact that this type of inspection would produce a greater control over moulding scrap. Hence we might expect to reduce moulding scrap costs as well.

NOTES ON UNEVALUATED HYPOTHESES

IDEA NO. 14 More careful mixing of compounds, to reduce the amount of compound rejected by the technical department. This would also mean that batches would be more likely to perform to moulding standards.

IDEA NO. 15 Increase the testing of mixed compound to eliminate any possibility of poorly mixed compound. Also, this would provide information for optimum moulding conditions for the moulding foremen.

IDEA NO. 16 Provide equipment for finishing operators, to allow them to inspect their own work, so reducing the final amount of inspection.

NOTES ON UNEVALUATED HYPOTHESES: (cont)

IDEA NO. 17 The generation of interest in the job, and responsibility towards the department.

This idea hs been formed as a result of my personal opinion of the attitudes on the shop floor. There appears to be a general feeling of apathy, which seems to be partially generated by the general situation with regard to the Factory's future.

I feel that interest could be generated if the operators knew what 'their parts' were used for, and how important they are. This information could be supplied by lectures and films, similar to those provided for the No. 1 Factory by the Girling Company. However, this type of approach alone is unlikely to have any lasting effect. There should be some form of 'follow up' or reminder, or perhaps, in the form of brief talks, and 'cut away' models placed strategically on the shop floor.

The Departmental Manager agrees that this idea could produce improvements in production standards. However, to estimate the effect of the idea in terms of a financial saving is very difficult. Thus, it would be difficult to justify any financial expenditure.

IDEA NO. 18 Produce a production control system for the department, capable of providing daily information on the exact situation of parts in the department. This might be done by the design of a large 'master board' which could be adjusted daily to show which parts were at the various stages

NOTES ON UNEVALUATED HYPOTHESES: (cont)

IDEA NO. 18 (cont)

This would then provide the information for production control and planning.

IDEA NO. 19

Use the computer facilities to produce compound mixing, moulding and finishing programmes. This would be dependent on the department acquiring a computer terminal to allow a daily up dating of input information. This might be justified on a labour saving and for an improved despatch situation.

IDEA NO. 20 A comparative evaluation of Compression and Injection moulding processes.

The evaluation would be a thorough examination of both production processes from the Barwell through to the inspection stage.

This examination would consider present conditions in the department, situations or 'set-ups' involving the most modern plant and possible improvements in techniques and machinery.

Following this, models might be produced which would define optimum operating conditions, and predict the effects of varying parameters.

NOTES ON UNEVALUATED HYPOTHESES: (cont)

IDEA NO. 20 - cont.

The results of the work would then provide the basis for future decision making, in a situation where both types of moulding appear practical. At present these decisions appear to be based more on personal opinions than facts.

The main arguments 'for and against' the idea would appear to be as follows:

PROS

1. The information would provide the basis for decision making, where large capital outlay might be involved.

2. The information gathered and the models produced might illustrate areas of the present 'set-up' which require modification.

3. The results of the evaluation might indicate the type of business that should be tendered for in the future.

CONS.

1. The project is not attempting to make any direct saving in the department.

2. If the price of parts is purely done on a 'cost plus' basis, then the method of production is not so important.

SUMMARY OF SCRAP COSTS IN THE LOCKHEED DEPARTMENT:

1.1. Cost of Scrap:

From this report, it is estimated that the cost of labour materials, maitenace and power in scrap production is = £160,304 p.a.

1.2. Number of Parts produced to the required scrap standard:

A certain amount of scrap is expected, and allowed for in the selling price of the parts. However, only 50 out of a possible 460 parts, at present in production, are being produced with scrap levels lower than those assigned to them.

1.3. Scrap Diagrams:

The attached sheets are diagrammatic representations of the production process illustrating, where possible, the places where scrap is produced and the quantity.

1.4. Unrecorded Scrap:

The collection of information for this summary highlighted the following areas where scrap has not been recorded**:

1.4.1. Blanks dropped by operators.

1.4.2. Scrap produced at the beginning of each shift by Edgwick Operators.

1.4.3. At the Clicking Machines.

1.4.4. Wheelabrator and Freeze Trim Sorting.

1.4. Unrecorded Scrap: (cont)

Now the departmental scrap report is based on information provided by the inspection area, i.e., the number of good parts, and the number of parts which are finishing and moulding scrap. Since in the areas mentioned and above, parts disappear, the information supplied on the scrap report is not totally correct.

(**NOTE: The situation should improve as a result of the introduction of the new batch card system. This involves the recording of any scrap, rejected at any stage).

2.0. Figures taken from the weekly scrap report, over a period of 32 weeks production -
(Week ending 9th April 1971 - 26th November 1971)

2.1.

Total parts produced	=	34.027,626
Total GOOD parts produced	=	23,561,079
Total SCRAP parts produced	=	10,466,607
Total Moulding scrap	=	7,025,980
Total Finishing scrap	=	3,441,627

2.2. Edgwicks:

Total parts produced	=	24,876,561
Total GOOD parts produced	=	18,114,679
Total SCRAP parts produced	=	6,761,882
Total Moulding scrap	=	4,216,660
Total Finishing scrap	=	2,545,222

2.0. Continued -

2.3. Compression:

Total parts produced	=	9,151,065
Total GOOD parts produced	=	5,446,340
Total SCRAP parts produced	=	3,704,725
Total Moulding scrap	=	2,809,320
Total Finishing scrap	=	895,405

2.4. TOTAL SCRAP = 31% of TOTAL PARTS PRODUCED.

Of the total parts produced 73% are produced on the Edgwicks, the remaining 27% being produced on the Compression Machines.

2.5. Comparison of Edgwick and Compression Scrap Percentages:

		EDGWICK.	COMPRESSION.
2.5.1.	Total Scrap as % of total parts produced	27%(31%)	41%
2.5.2.	Total Moulding Scrap as % of total scrap	63%	76%
2.5.3.	Total Finishing Scrap as % of total scrap	37%	24%

3.0. Estimation of the cost of scrap production in terms of labour costs:

3.1. The Labour Costs of Moulding the Scrap

This cost was estimated by firstly calculating the total wages bill for all direct and relevant indirect labour, for the two types of moulding.

3.0. Continued -

3.1. (cont)

Then using the figures obtained from the scrap report i.e., in the case of Compression moulding 41% scrap, therefore, assumed 41% of moulding labour was employed in producing scrap.

3.1.1. Compression Moulding

Total Wages	=	£85,850	
	+	£ 7,300	(Nat.Ins. + Insurance - based on employer's cont).
	=	£93,100 p.a.	

Therefore, Labour Cost of moulding scrap

= £38,200 p.a.

3.1.2. Injection Moulding

Total Wages	=	£72,400
	+	£ 5,150
	=	£77,550 p.a.

Therefore, Labour Cost of moulding scrap

= £21,000 p.a. *

NOTE: The figure recorded on the previous section (3.1.) * is similarly adjusted for this unrecorded figure.

3.2. Labour Costs of Finishing Scrap:

This value was estimated by firstly calculating the total wages bill for all finishing and inspection labour. Then obtaining an estimate on the cost ratio of finishing Edgwick and Compression parts from the Departmental Manager of 1 : 5 i.e. 3 Edgwick parts finished for the cost of 2 Compression parts.

3.0. Continued -

3.2. (cont)

Using this ratio, the total number of Compression parts was converted into 'Edgwick equivalent parts'. Finally, the total labour costs were then apportioned accordingly to the percentage of Edgwick and Compression (Edgwick equivalent) parts, as a percentage of the total parts produced.

NOTE: This value of 1 : 5 for the ratio of finishing costs has been checked against figures obtained from the cost exercise recently completed. The ratio for the present parts appears to be approximately 1 : 1.7 and the difference this makes to the figures quoted is small, 4%.

3.2.1. <u>Division of labour costs:</u>

Total no of Compression parts	=	9,151,065
Total no. of Edgwick equivalents	=	9,151,065 x 1.5
	=	13,726,598
Total no. of Edgwick parts	=	24,876,561
Total Edgwicks + Edgwick Equivalents	=	38,603,159
Edgwick % of total	=	64%
Edgwick Equivalent % of total	=	36% (Compression)

3.2.2. <u>Labour Costs:</u>

3.2.2.1. Cost of Finishing Labour = £132,100 p.a.

3.2.2.2. Cost of Inspection Labour = £ 66,600 p.a.

3.0. Continued -

3.2. (cont)

3.2.3. Labour cost of 'finishing' compression scrap:

3.2.3.1. Cost of Finishing Labour = 41% + (36% of £132,100 pa

= £19,500 p.a.

3.2.3.2. Cost of Inspection Labour = 41% of (27% of £66,600 p.a.)

= £7,400 p.a.

3.2.3.3. Labour cost of Finishing + Inspecting Compression Scrap = £26,900 p.a.

3.2.4. Labour cost of 'finishing' Edgwick scrap:

3.2.4.1. Cost of Finishing Labour = 27% of (64% of £132,1C p.a

= £22,800 p.a.

3.2.4.2. Cost of Inspection Labour = 27% of (73% of £66,60C p.a.

= £13,100 p.a.

3.2.4.3. Cost of finishing and inspecting Edgwick Scrap = £34,900 p.a.

4.0. Estimation of material costs in scrap production:

4.1. Material rejected by the Technical Department

As a result of testing, by the Technical Department, after mixing 3.2% of mixed compound is rejected.

4.0. Continued -

4.1. (cont)

Now 99% of this rejected compound is remilled, and a small loss is incurred, as a result of wasted labour. The remaining 1% being scrapped at a cost of £25 p.a. This figure being 1% of (3.2% of £77,500 p.a). (£77,500 p.a. total annual materials costs, from accounts sheet).

4.2. Material returned from the 'Blank and Cord' Stores:

At the 'Blank and Cord' Stores material may be returned due to ageing, incorrect blank size, scrap part production, etc. etc. Statistics available were limited, but indicated that 9% of all compound is returned (8% blanks - 1% cord) 4% is the scrapped, the other 5% being remilled.

Hence the material cost in scrap was 4% of 9,100 kgm/week (figures from Barwell operators' work sheets).

i.e., $50 \times 9{,}000 \times \frac{4}{100}$ kgms @ 17np/kgm

Cost of material scrapped at this stage = £3,100 p.a.

(NOTE: Account was also taken of wasted Barwell labour).

4.3. Material wasted on moulding machines:

4.3.1. Compression Operators dropping blanks on the floor.

Estimated 1% wastage at a cost of £180 p.a.

4.0. Continued -

4.3. (cont)

4.3.2. Material wasted by Edgwick operators at the start of each shift. At the end of each shift the machines have to be filled with smoked rubber to prevent the machines 'curing up' and jamming. Hence at the start of each shift, compound is used in 'cleaning' rubber from the machine - 5% of compound used on the Edgwicks is used in this manner, plus a quantity of smoked sheet rubber.

Cost of 5% of total cord used on the Edgwicks

= £2,300 p.a.

Cost of smoked sheet rubber was calculated from a figure for the total weight used per year (supplied by the Chief Foreman).

= £300 p.a.

4.4. Material used in the production of scrap parts:

The total material used in the two types of moulding was found from the Barwell operators' work sheets. Then it was assumed that the material in scrap was equal to total percentage of scrap of the two types of moulding .

4.4.1. We see from the material scrap diagram that 23% of the original total material mixed for the department is used in Compression moulding.

In cost terms, this is equivalent to 23% of £77,500 p.a. Similarly, the material costs for injection moulding = 57% of £77,500 p.a.

4.0. Continued:

4.4. (cont).

4.4.2. Cost of materials in Compression scrap:

Of the 23% of material used:

a) 4.4% is waste, lost at the 'clicking and trim' stage.

b) 18.6% is used in the production of parts, now the scrap level is 41%.

Therefore, costs are:

a) (41% of 4.4%) of £77,500 p.a. = £1,398 p.a.

b) (41% of 18.6%) of £77,500 p.a. = £5,910 p.a.

4.4.3. Cost of material in Injection Scrap:

Of the 57% of material used:

a) 17.6% is waste lost at the 'clicking and Trim' stages.

b) 39.4% is used in the production of parts, now the scrap level is 27%

Therefore, scrap costs are:

a) (27% of 17.6%) of £77,500 p.a. = £3,677 p.a.

b) (27% of 39.4%) of £77,500 p.a. = £8,244 p.a.

4.5. Cost of Material returned from the Barwell

This is due to the fact that a certain amount of compound is left in the machine after use. This has been estimated at 5% of all compound used on the Barwell, by the Barwell Foreman.
Of this 5% - 1.5% is scrapped, and 3.5% remilled.
Cost of the 1.5% is estimated at £1,150 p.a.

5.0. Cost of 'Power' in Scrap Production:

This has been estimated on the basis that 34% of the total annual power consumption has been used in producing scrap.

The annual 'power' consumptioncosts were found from Direct and Indirect Variable Sheets.

These figures were:

Power	=	£11,700 p.a.
Heat and Steam	=	£ 8,350 p.a.
Water	=	£ 2,300 p.a.
TOTAL	=	£22,350 p.a.

i.e., 'Power' costs of scrap production = £7,600 p.a.

6.0. Total Cost of Scrap Production:

	INJECTION.	COMPRESSION.
Labour Costs		
Moulding	£23,600	£38,200
Finishing	£22,800	£19,000
Inspection	£13,100	£ 7,400
Barwell	£ 540	£ 1,305
Material Costs		
Barwell	£ 735	£ 415
Blank + Cord Stores	£ 345	£ 2,755
On Machines	£ 6,277	£ 1,578
In Scrap	£ 8,244	£ 5,910
TOTAL	£75,641	£77,063

6.0. Continued -

	INJECTION.	COMPRESSION.
Power Cost:		
Total Labour, Materials and Power Costs of Scrap =	£7,600	

Much of this information has now been tabulated (overleaf) in order that comparisons can be made between Injection and Compression Moulding.

COST FIGURES FOR INJECTION AND COMPRESSION MOULDING:

(A) INJECTION MOULDING:

1.0. Estimated average cost of labour, materials, maintenance and power:

	(i) per part	-	£0.00785
	(ii) Per GOOD part	-	£0.0108
2.0.	Estimated average cost of labour:		
	(i) per part	-	£0.00546
	(ii) per GOOD part	-	£0.00753
2.1.	Total labour cost of production	-	£213,100 p.a.
2.2.	Cost of moulding labour	-	£ 77,500 p.a.
2.3.	Cost of Finishing and Inspection Labour	-	£127,100 p.a.
3.0.	Estimated average cost of materials:		
	(i) per part	-	£0.00121
	(ii) per GOOD part	-	£0.00155
3.1.	Estimated material costs	-	£47,000 p.a.
4.0.	Estimated average cost of maintenance:		
	(i) per part	-	£0.00070
	(ii) per GOOD part	-	£0.00096
4.1.	Estimated total maintenace cost	-	£27,370 p.a.
5.0.	Cost of moulding scrap	-	£47,274 p.a.
	5.1. Moulding labour in moulding scrap	-	£15,800 p.a.
	5.2. Finishing labour in moulding scrap	-	£14,350 p.a.
	5.3. Inspection labour in moulding scrap	-	£ 8,250 p.a.
	5.4. Materials in scrap	-	£ 8,871 p.a.
6.0.	Cost of Finishing Scrap:	-	£24,150 p.a.
	6.1. Moulding labour in finishing scrap	-	£ 7,800
	6.2. Finishing labour in finishing scrap	-	£ 8,450

(cont...)

(A) INJECTION MOULDING: (cont)

6.0. Cost of Finishing Scrap: (cont)

6.3. Inspection labour in finishing scrap	-	£ 4,850
6.4. Materials in finishing scrap	-	£ 3,050

7.0. Average Selling Price - £0.0137

(B) COMPRESSION MOULDING:

1.0.	Estimated average cost of labour, materials, maitenance and power:		
	(i) per part	-	£0.0193
	(ii) per GOOD part	-	£0.0325
2.0.	Estimated average cost of labour:		
	(i) per part	-	£ 0.0118
	(ii) per GOOD part	-	£ 0.0201
2.1.	Estimated total labour cost of production	-	£169,100 p.a.
2.2.	Cost of Moulding labour	-	£ 93,100 p.a.
2.3.	Cost of Finishing and Inspection Labour	-	£ 71,600 p.a.
3.0.	Estimated average cost of materials:		
	(i) per part	-	£0.00169
	(ii) per GOOD PART	-	£0.00285
3.1.	Estimated materials costs	-	£24,200
4.0.	Estimated average cost of maintenance		
	(i) per part	-	£0.00535
	(ii) per GOOD part	-	£0.00890
4.1.	Estimated total maitenance cost	-	£76,640 p.a.
5.0.	Cost of Moulding Scrap:	-	£55,342 p.a.
	5.1. Moulding labour in moulding scrap	-	£29,000
	5.2. Finishing labour in moulding scrap	-	£14,800
	5.3. Inspection labour in moulding scrap	-	£ 5,650
	5.4. Materials in moulding scrap	-	£ 5,892
6.0.	Cost of Finishing Scrap	-	£17,018 p.a.
	6.1. Moulding labour in finishing scrap	-	£ 9,200
	6.2. Finishing labour in finishing scrap	-	£ 4,700
	6.3. Inspection labour in finishing scrap	-	£ 1,700
	6.4. Materials in finishing scrap	-	£ 1,418
7.0.	Average Selling Price	-	£0.0290

Source of information used to compile the scrap diagrams

	Production Area	% Scrap at this area	Value of Material	Source of Information
1.	Technical, Inspection after mixing.	3.2% (of which 99% is remilled and 1% Scrap)	£25 p.a.	3.2% found from the weekly report sheets. 1% from P. Woods the technical "tester"
2.	Barwell	5% not used 3.5% remilled and 1.5% Scrap)	£1,150 p.a.	Estimated by Barwell. Foreman F. Carolan.
3.	Blank & Cord Stores	9% returned (8% blanks and 1% cord) (of the 9%-5% remilled and 4% scrap.)	£3,100 p.a.	Blank Storeman's weekly return sheet, and inspection record book.
4. a)	Compression Moulding	30% moulding scrap	£5,755	Figure computed from the weekly scrap report.
4. b)	Compression Moulding	1% scrap, due to operators dropping blanks	£180 p.a.	Estimated by two Moulding Foremen
5. a)	Injection Moulding	5% scrap at the beginning of each shift	£2,300 p.a.	Estimated by Mouldi[illegible] Foreman E. Edwards
5. b)	Injection Moulding	Scrap, smoked sheet rubber left in the m/c between shifts	£300 p.a.	Weight estimated by M. Foy (Senior Foreman)
5. c)	Injection Moulding	17% moulding scrap	£7,450 p.a.	Figure from weekly scrap reports.
6.	Finishing Department	10% scrap for injection moulding	£4,400 p.a.	Figures taken from the departmental weekly scrap report

APPENDIX B

PRESENTATION - REPORT ON POTENTIAL SAVINGS IN THE LOCKHEED DEPARTMENT.

THE PRESENTATION OF THE REPORT ON POSSIBLE SAVINGS IN THE LOCKHEED SEAL DEPARTMENT

Presented By: Mr J R Bainbridge
IHD Student

Mr T B Tate
Visiting Lecturer
University of Aston

Presented To: Mr D A Air
Manager
Skelmersdale

16th June 1972

PURPOSE OF THE MEETING

1. To consider the overall prospects for the Lockheed Dept.

2. To review the savings opportunities identified and analysed in the report.

3. To decide what action should be taken in each case
   - Implementation
   - Preparation work
   - Testing on a small scale

4. To allocate the required actions to:-
   - IHD Student
   - Ind. Eng. Dept.
   - Other Factory Depts. or Staff

SUBSTANTIAL CUTS IN MANPOWER WOULD BE NEEDED TO ELIMINATE THE LOCKHEED DEPARTMENT's LOSS

(1971 FIGURES)

	£,000's
LABOUR (INC. £80,000 MAINT. LABOUR	498
MATERIALS	95
MAINTENANCE MATERIALS	42
POWER	23
DIRECT COST SUB TOTAL	658
OVERHEADS	270
TOTAL COST	928
REVENUE	627
LOSS	£301

A cut of £214,000 in Direct Costs would suffice, if overheads remain at ~41% of Direct Costs

- 43% cut in Manpower

OR 32.5% cut in all Direct Costs

A PRELIMINARY ANALYSIS OF IMPROVEMENT OPPORTUNITIES SUGGESTS THAT A £214,000 P.A. COST REDUCTION IS NOT COMPLETELY OUT OF THE QUESTION

A	OPPORTUNITIES ALREADY EVALUATED	VALUE
	4 with negative values	0
	2 of a special type reclassified	0
	3 implementable at once	£10,000
	5 requiring further development	£104,000
		£114,000

B	OPPORTUNITIES YET TO BE EVALUATED	POSSIBLE VALUE
	- Spin-offs from evaluated projects	£57,000
	- Current projects not included above	£20,000
	- Defined ideas not yet evaluated	£6,000
	- Undefined ideas	£20,000
		£103,000

Total evaluated	£114,000
Total not evaluated	£103,000
GRAND TOTAL	£217,0000

THE MAIN OPPORTUNITIES ARE:-

I LOSS MAKING IDEAS:

A Inspect all parts after moulding

B Inspect all Edgwick parts after moulding

C Run Edg.Peco. + Hydrason 3 shift male labour

D Eliminate the part finished stores

II TECHNICAL STRATEGY IDEAS:

E Compare comp. and inj. moulding

F Improve the production control system

III LOW STEP-UP COST IDEAS:

G Reduce the Edgwick cycle time

H Develop a program for the Barwell

I Improve the use of Technical Data

IV IDEAS REQUIRING FURTHER DEVELOPMENT:

J Replace Hand-lathes by Auto-lathes

K Inspect comp. parts during moulding

L Improve inspection conditions

M Change 16 comp.parts to Inj. parts

N Re-group the finishing Dept. into small units

E COMPARE COMPRESSION AND INJECTION MOULDING

- Attempt to define limiting and optimum operating conditions for both types of moulding, at present and in the future.

- Providing information for future decision making.

THE PROJECT WOULD INVOLVE EXAMINING:-

- The techniques at each stage of production
- Possibilities of automation
- Compound preparation
- Moulding parameters
- Development of machines

POSSIBLE "SPIN-OFFS"

1. Reduced labour force
2. Reduced maintenance costs
3. Reduced scrap costs

Although the Project would provide the Company with useful information, the fact that selling price is on a "Cost Plus Basis" puts some of the onus of research on Lockheed (A.P.)

- Also the Project will not in itself reduce the loss of the Department.

RECOMMENDATION : That those parts of the Project which could result in cost savings be researched individually.

F IMPROVE THE PRODUCTION CONTROL SYSTEM

BENEFITS

1. Reduction in W.I.P. Stocks
2. Reduction in Planning Staff
3. Improved information system
4. Unevaluated benefits

   Reduced scrap and lateness

   Improved machine utilisation

CONS.

1. Increased operator hostility arising from tighter control, and increased rigidity of the system.
2. Cost of operator time to fill in the batch cards
3. Cost of processing information

PRO'S v CON'S

1.	W.I.P.	£10,000	1.	Cost of time to fill in batch cards ~£500
	∴ 10% saving	£1,000		
2.	Reduction in Planning staff	£1,000		
3.	Information	0		
	TOTAL	£2,000		£500

NET SAVING ~£1,500 P.A.

RECOMMENDATION: In view of the operator unrest the Project would be better left for evaluation at a later date.

Three of the opportunities have small set up costs and could be implemented almost immediately.

These are:-

G REDUCE THE EDGWICK CYCLE TIME BY 20%

NET SAVING ~£8,000 P.A.

MADE UP OF:

Reduced Edgwick labour cost ~£9,400 P.A.
LESS increased maintenance costs ~1,300 P.A.

ACTION REQUIRED

Scrap and maintenance monitoring forms, to be produced by J. Bainbridge.

- Technical Departments' research indicates that all cycle times could be cut by 10 - 20%
- Some by up to 50%

H DEVELOP A PROGRAM FOR BARWELL PRODUCTION

NET SAVING ~£1,900 P.A.

MADE UP OF

LABOUR ~£2,100 P.A.

LESS MATERIALS ~£190

ACTION REQUIRED

- Program and forms to be developed by J. Bainbridge and the Moulding Foremen
- Monitor downtime after implementation.

I MAKE TEST DATA AVAILABLE TO MOULDING FOREMEN

NET SAVING ~£600 P.A.

MADE UP OF

LABOUR ~£290

MATERIALS ~£310

ACTION REQUIRED

Develop techniques with moulding Foremen and Tech. Dept.

"LARGE POTENTIAL SPIN-OFFS"

1. Reduce scrap by improved test specification
2. Reduce scrap and improve productivity by better press operation.

The remaining five opportunities require further development before any decisions on implementation can be taken.

These are:-

J REPLACE 22 HAND LATHES BY 6 AUTO-LATHES

NET SAVING ~£10,000 P.A. CAPITAL COST~£11,500

MADE UP OF

SAVING OF HAND-LATHE LABOUR £20,030 P.A.

LESS COST OF AUTO-LATHE LABOUR ~£10,020 P.A.

ACTION REQUIRED

Decide on type of auto-lathe by examination of various types of lathes.

- Combine with this the present Ind. Eng. Hand-lathe project.

Two opportunities involving Inspectors could be tested on a small scale.

These are:-

K INSPECT A SAMPLE OF COMP. PARTS DURING MOULDING

ESTIMATED SAVING ~£16,000 P.A. *

MADE UP OF:-

Reduction in Scrap costs ~ £22,100 P.A.

Reduction in Maintenance costs£9,200 P.A.

LESS Inspection Costs ~£15,250 P.A.

(* Depends on the effectiveness of the Inspectors).

ACTION REQUIRED

- Design a scheme or method of sample inspection, and if results indicate set up a team of Inspectors.

L IMPROVE THE INSPECTION CONDITIONS IN THE FINISHING DEPARTMENT

ESTIMATED SAVING ~£10,000 P.A.*

MADE UP OF

REDUCTION OF THE NUMBER OF INSPECTORS

(* Saving estimated on a 15% increase in inspector o/p)

ACTION REQUIRED

- Test a small sample of Inspectors under various conditions.
- If results indicate sufficient improvement, investigate the cost of improvements.

The two remaining opportunities offer the largest savings.

These are:-

M **CONVERT 16 COMPRESSION MOULDS TO INJECTION MOULDS**

ESTIMATED SAVING ~£39,000 P.A.

CAPITAL COST ~£30,000

MADE UP OF:-

REDUCED LABOUR COSTS

REDUCED MAINTENANCE COSTS

ACTION REQUIRED

- Consultation with Lockheed on:-
  - Acceptability
  - Prices
  - Supplying the moulds

N DIVIDE THE FINISHING DEPARTMENT INTO SMALLER UNITS

ESTIMATED SAVING ~£27,000 P.A.

MADE UP OF:-

REDUCTION IN FINISHING SCRAP COSTS

POSSIBLE SET UP COSTS ~£2,000

ACTION REQUIRED

- Evaluate the possibilities for isolation

"SPIN-OFFS"

- Follow up to the introduction of leading Hands
- Reduced movement of work
- Increased operator eff.

SPIN-OFFS COULD CONTRIBUTE ABOUT £57,000 P.A.

HYPOTHESIS		POSSIBLE VALUE £,000's P.A.
I	Improve the use of technical data.	
	- Reduce scrap by 10% through better test specification.	10
	- Reduce moulding scrap by 10% by improved press operation.	10
	- Reduce press operators by 10% through improved press speeds	17
J	Replace hand-lathes by auto-lathes.	
	- Reduce finishing scrap for compression parts from ~1/6 of good moulded parts to ~1/9 of good moulded parts. (as for injection, where most parts are on auto-lathes). Thus reducing compression scrap from 40% to 36%.	7
M	Re-group the finishing department into smaller units	
	- Improve output by 10% due to higher moreale and less movement	13
		~~63~~ 57

OTHER UNEVALUATED OPPORTUNITIES COULD CONTRIBUTE A FURTHER £46,000 P.A.

	POSSIBLE VALUE £,000's, P.A.
CURRENT PROJECTS	
Reduce inspectors by 1/3 by re-training	20
DEFINED IDEAS NOT YET EVALUATED	
- Inspect more compound more thoroughly	?
- Train operators to inspect their own work	?
- Increase finishing machine utilisation by better scheduling reducing finishing operators by 10%.	6
UNDEFINED IDEAS	
- Convert a further 12½% of compression parts to injection	20
	46

Before deciding what resources can be allocated to the implementation and development of the eight specific beneficial opportunities, some of the organizational issues are highlighted and solutions proposed.

<u>The profit improvement opportunity approach pursued by independent agents has both strengths and weaknesses</u>

<u>Strengths</u>

1 Frees up thinking from usual constraints
2 Involves personnel concerned when discussing pros. and cons.
3 Introduces a disciplined approach in quantifying pros and cons in a systematic and rigorous way.

<u>Weaknesses</u>

1 Can count benefits twice
 - e.g. improving inspection conditions and re-training inspectors.
2 Can lead to misallocation of research effort, unless co-ordinated.
 - e.g. auto-lathes and better hand-lathes.
3 Can lead to poor high level planning, unless communicated regularly to a sufficiently high level.
 - e.g. possible premature closure of a department.
4 Can lead to operator or manager resistance unless full involvement, understanding, and acceptance is secured at the beginning.

<u>To remedy the weaknesses the following organizational changes are suggested</u>

1 The responsibility for co-ordinating and for reviewing progress on all profit improvement ideas frequently should be allocated to the appropriate level, e.g. product manager or department manager.

2 Firm targets for review frequency and stretching ones for creativity, and for evaluation and implementation time tables should be set for the executive responsible.

3 All current projects affecting the department, in this case Lockheed, should be listed and evaluated on the above basis.

4 Full time or part time teams should be set up to carry out the evaluation and implementation of the work.

5 The scale of experiments, the intention to increase the security of the department by introducing many changes, and the implications for the number of men to be employed need to be discussed with the unions and staff.

   - It is usually possible to guarantee no redundancy and that improvements are to be in effectiveness rather than in men working harder.

   - With these guarantees the unions may wish to contribute ideas, watch experiments, or participate in teams.

   - At the least they should expect frequent progress reports, and this is usually a sensible move.

FIRST £100,000 ACTION NEEDED

1.	Reduction of Edg. cycle time	→ J.R.B.
2.	Barwell Programme	
3.	Use of Tech. Data	

4.	Replace hand-lathes by Auto-lathes	→ IHD Eng.
5.	Inspection of comp. parts	→ Exp. + J.R.B.
6.	Improve Inspection conds.	
7.	Replace comp. moulds by injection moulds →	
8.	Re-group finishing dept. into smaller units	→ Team

SECOND £100,000

9. Establish team for project evaluation

APPENDIX C

A COMPARATIVE ANALYSIS OF THE LOCKHEED DEPARTMENT'S ACCOUNTING RATIOS.

Submitted by : Mr.J.R.Bainbridge I.H.D. Student.

Submitted to : Mr.J.M.Lawrie Product Manager.

C O N T E N T S

COMPARATIVE ANALYSIS OF THE LOCKHEED DEPARTMENT'S ACCOUNTING RATIOS

Aim of the Report

To produce the accounting ratios of the Lockheed Department and compare them with those produced by the Centre for Interfirm Comparison, and also the Girling Department. The report will also provide a basis for future evaluation of Departmental progress.

Procedure

Using the definitions for various ratios as outlined in the Interfirm Comparison Report (1971) the equivalent ratios were calculated for the Lockheed and Girling Departments.

These results were then tabulated along with the Median Value, and values for firms Nos. 10 and 13 from the Interfirm Comparison Report. (Firm 13 being Dunlop, G.R.G. Division, and Firm 10 supplying 60% of it's sales to the Automotive Industry, and having a sales turnover in a similar range to Lockheed).

Conclusions

A detailed examination of the ratios can be found in the appendix. The main conclusions were as follows:-

1. The Department is running at a loss and the two ways of affecting a change on the profit/loss margin are:-

1.1. Increase the selling price, to produce an increased sales revenue for the same production costs.

1.2. Reduce the total production costs of goods sold.

As can be seen from the appendix it is likely that a combination of both 1.1. and 1.2. will be required to rectify the situation.

A reduction in total production costs could be achieved by reducing the following.

1.3.1 Direct Material Costs

1.3.2 Direct Labour Costs

1.3.3 Production overheads especially A. Maintenance Costs B. Indirect Labour Costs

All these reductions should be considered important Departmental objectives.

Continued ...

Conclusions (Continued)

2. Management of Departmental Assets is not good, and consideration should be given to reducing stocks, and "Other Assets" in the Fixed Asset total.

TABLE 8.1. ACCOUNTING RATIOS

	MEDIAN VALUE I.C.R.	FIRM NO. 13	FIRM NO. 10	LOCKHEED 1971	LOCKHEED MID 1972	GILLING 1971	GILLING MID 1972
1. RETURN ON ASSETS							
1.1. OPERATING PROFIT (LOSS) / OP. ASSETS	8.2	0.3	7.1	-61.8	-50.6	29.2	51.3
2. PROFIT MARGIN AND ASSET TURNOVER							
2.1. OP. PROFIT (LOSS) / TOTAL SALES (%)	4.6	0.2	4.4	-51.9	-47.7	17.8	24.7
2.2. TOTAL SALES / OP. ASSETS	1.36	1.36	1.61	1.20	1.07	1.67	2.07
3. DEPARTMENTAL COSTS AS A % OF SALES							
3.1. TOTAL PROD. COSTS AS A % OF GOODS SOLD	79.9	93.1	78.6	140.5	135.6	71.4	65.9
3.2. DISTRIBUTION COSTS	3.4	2.6	3.5	3.2	3.0	1.5	1.5
3.3 SELLING AND MARKETING COSTS	4.4	3.7	5.1	3.4	3.6	3.1	2.6
3.4 ADMIN. COSTS	4.4	0.4	8.4	4.8	5.2	6.2	5.2
4. PRODUCTION COSTS (AS A % OF SALES)							
4.1 DIRECT MATERIALS	40.9	47.8	40.9	13.8	18.4	6.0	6.5
4.2 PROD. LABOUR COSTS	20.9	18.9	29.2	53.3	46.8	22.0	21.9
4.3 PROD. OVERHEADS	22.3	27.2	9.4	73.4	70.4	46.5	37.5
4.2. PROD. LABOUR COSTS AND PRODUCTIVITY							
4.2.1. COSTS PER. DIRECT OPERATIVE	893	907	1046	1438	1376	1174	1267
4.2.1 VALUE ADDED PER. DIRECT OP.	3159	2570	4073	2363	2474	4920	5419
4.2.3. VALUE ADDED PER. PROD. EMPLOYEE	2354	1875	3530	1822	1858	4131	4694
4.2.4. VALUE OF UNDEPRECIATED PLANT PER.DIR.OP.	1733	1975	703	686	863	-	-
4.2.5. NO. OF DIR. OPS. PER SUPERVISOR	9.7	21.9	9.3	25.4	31.7	22.2	26.5
4.2.6. No. OF PROD. EMPS. PER SUPERVISOR	11.6	29.3	10.7	33.0	42.2	24.2	28.0

TABLE 8.2. ACCOUNTING RATIOS

	MEDIAN VALUE I.C.R.	FIRM No. 13	FIRM No. 10	LOCKHEED 1971	LOCKHEED MID.1972	GIRLING 1971	GIRLING MID.1972
4.3. PROD. OVERHEAD (AS A % OF SALES)							
4.3.1. PROD. MANAGEMENT AND CONTROL	2.75	1.58	1.56	9.7	10.5	9.2	7.7
4.3.2. INDIRECT LABOUR	6.83	6.17	1.90	19.0	14.6	8.6	7.4
4.3.3. MAINTENANCE	-	-	-	19.6	12.9	10.0	8.0
4.3.4. DEPRECIATION OF PLANT AND MACHINERY	2.91	2.74	0.68	11.0	12.9	5.6	4.6.
4.3.5. OTHER PRODUCTION OVERHEADS	13.07	16.4	5.24	14.0*	19.5*	13.1*	9.8*
					(Excluding Maintenance Costs - *)		
5. CURRENT AND FIXED ASSETS (per £1,000 of sales)							
5.1. TOTAL ASSETS	736	736	623	834	937	601	483
5.2. CURRENT ASSETS	329	314	353	290	351	307	235
5.3. FIXED ASSETS	419	422	270	544	586	294	249
5.2. CURRENT ASSETS (per £1,000 of sales).							
5.2.1. STOCKS	137	181	94	141	210	94	75
5.2.2. DEBTORS	191	133	259	149	141	214	160
5.3. FIXED ASSETS (per £1,000 of sales)							
5.3.1. FACTORY LAND AND BUILDINGS	236	238	207	144	153	255	219
5.3.2. PLANT AND MACHINERY	184	155	57	250	275		
5.3.3. OTHER FIXED ASSETS	13	29	6	150	153	39	30
5.3.1. LAND AND BUILDINGS							
VALUE OF LAND AND BUILDINGS per.sq.foot.	2.8	2.3	3.8	2.9	2.9	-	-
SALES per.sq.ft.	12.2	9.5	13.5	20.3	18.1	16.0	19.3
VALUE ADDED per. sq. ft.	7.4	5.1	8.8	17.5	14.1	14.9	18.1

APPENDIX A

Comments on Lockheed Accounting Ratios

The following is an examination of 1971 figures, which will then be used as a basis of evaluation of Departmental progress.

1. Return on Operating Assets

Ratio 1 relates the achievement of Management to the resources available to them. Since there is a negative value for ratio 1, this indicates that resources have not been used profitably.

2. The result of ratio 1 of - 61.8% is a combination of ratios 2.1 and 2.2. 2.1 is a profit/loss margin on sales of-51.9%. 2.2 is a rate of asset turnover of 1.20 times per year.
So there is a negative profit margin and an asset turnover rate below the median.

3. Departmental Costs (as a % of Sales)

The figures in this section are responsible for determining the profit/loss margin.

In the Lockheed Department the loss margin of 51.9% is a direct result of total production costs running at 140.5%. The other Departmental Costs in this section being at approximately the quoted median value.

This total production cost is almost double the quoted median and Girling values of 79.9% and 71.4% respectively.

4. Production Costs (as a% of Sales)

The high production costs can be attributed to the high production labour, and production overhead costs. These will be examined in detail in this section.

4.1. Direct Materials Cost

Although the ratio 4.1 is low compared with the quoted median, at 13.8% the Lockheed value is more than double that of Girling.

Continued ...

APPENDIX A (Continued)

4.2. Production Labour Costs

The high production labour ratio (4.2) for Lockheed is one of two major causes of the Departmental loss. The value of 53.3% is almost two and a half times the median and Girling value.

Breaking this down further, the value of cost per direct operative (4.2.1) at £1,438 is almost twice the median value and higher than the Girling value.

One interpretation of these facts is that in 1971 Lockheed was 40% overstaffed compared to Girling, and was paying direct operatives 22% more.

(1. Taking Production Labour Costs as a % of sales in 1971 the ratio for Lockheed : Girling was 53.3 : 22.0 = 2.42:1

i.e. Taking the Girling value as the mean, Lockheed costs exceed the mean by 142%.

2. Comparing the cost per direct operative in 1971 the ratio of Lockheed : Girling was 1,438 : 1,174 = 1.22 : 1

i.e. Direct operatives in Lockheed cost 22% more than Girling

Therefore Lockheed production labour costs excess above Girling is caused by higher direct operative costs and overstaffing).

Also the value added, per direct operative, and per production employee is only 3/5 of the value achieved by Girling.

Ratio 4.2.4. shows the low degree of capital intensity of the Lockheed Department compared with the median, unfortunately results are not available for Girling.

Finally the level of supervision is well below the quoted median value, but since it is almost equal to that of Girling, this becomes difficult to evaluate.

4.3. Production Overheads

The result for this ratio for Lockheed is 73.4%, compared with a quoted mean value of 22.3% or 46.5% for Girling. This ratio is therefore the second major factor responsible for producing a Departmental loss.

Continued ...

4.3. Production Overheads (Continued)

Thus breaking this ratio down further and making a direct comparison between Lockheed and Girling, we can see from the table that the following Lockheed ratios:

1. Indirect Labour (4.3.2.)
2. Maintenance (4.3.3.)
3. Depreciation (4.3.4.)

are all approximately double those for Girling.

(Note - the Depreciation figures for Lockheed and Girling can not be compared with the quoted mean, since they contain extra figures for Buildings, Fixtures and Fittings etc.)

Finally if, as in the Interfirm Comparison Report, the Maintenance costs are included in ratio 4.3.5., then other production overheads for Lockheed become almost two and a half times the quoted median.

5. Operating Assets (per £1,000's of Sales)

The Lockheed values for total and fixed assets are higher than the quoted median, while current assets are below the quoted value.

Further examination of fixed asset ratios (5.3) shows the value of land and buildings 5.3.1. to be below the median while plant and machinery and especially other fixed assets 5.3.3. are very much higher than the median.

Both stocks and debtors ratios for current assets compare favourably with the median values.

However, it is to be noted that a reduction in fixed assets i.e. "other fixed assets" especially, although having a beneficial effect on ratio 1, does not directly affect the profit/loss margin. Hence it would be possible to improve asset turnover, without altering the Departmental profit margin.

Finally it is of interest that in fixed asset consideration, it was found that the values of sales, and value added per sq. ft. were higher for Lockheed than the quoted mean. or Girling.

APPENDIX B

Changes required to achieve acceptable values for Important Accounting Ratios

1. Operating Profit/Total Sales (%) (2.1.)

Assuming a target value for the ratio of +10%, Lockheed value '71 = - 51.9%.

Assuming an increase in Sales Revenue of 25%, and taking Departmental Costs as in '71

Then the loss = £147,000

and ratio 2.1 = - 18.8%

Hence a target value of + 10% is only likely to be reacted by a 'reasonable' increase in Sales Revenue, combined with a decrease in Departmental Costs.

Assuming Departmental fixed costs remain approximately constant. Then the following combinations are required to achieve the target.

Increase in Sales +	Decrease in A. Dept. Cost	Decrease in B. Dept. Variable
25%	24.3%	33.5%
20%	28.3%	39%
15%	30.2%	41.6%
10%	33.5%	46.2%
5%	36.4%	50%

If Departmental costs remain constant then:

a) an increase in sales of 48.2% would achieve a 'Break-even' situation

b) an increase in sales of 62.7% would produce a value of +10% for ratio 2.1.

Hence we can see from the table that large reductions in Departmental variable costs will be required. These reductions would be obtained by a reduction of the following:

	% of Total Variable Costs	
1. Direct Materials	12.8%	= 93.2% of total Variable Costs
2. Direct Labour	48.8%	
3. Indirect Labour	13.5%	
4. Maintenance	18.1%	

Continued ...

APPENDIX B (Continued)

2. Total Sales/Operating Assets (2.2.)

Median Value = 1.36

Lockheed Value '71 = 1.20

Then taking the median value as the target the following figures are required:

Increase in Sales	Value of Asset to Give the Median	
5%	- £484,000	= fall of £39,000
10%	- £507,000	= fall of £16,000
15%	- £531,000	= increase of £8,000
20%	-£554,000	= increase of £31,000
25%	-£575,000	= increase of £52,000

i.e. If the total assets remain at - £523,000, then an increase in Sales revenue of ~15% is required to obtain the median value for ratio 2.2.

Limitations of the Report

The main source of limitation of accuracy is the valuation of Fixed costs. The figures used, those shown in the appendix, were the plan figures for 1972, based on 1971 costs. The main weakness of these figures is in the breakdown into the various categories. This then means that the accuracy of ratios 3.3., 3.4., 4.3.1., 4.3.4., and 4.3.5. are in some doubt. However, the overall total can be assumed to be substantially correct and so the major ratios can be assumed to be accurate.

JB/ACB
6.9.72

APPENDIX

DEPARTMENTAL ACCOUNTING FIGURES FOR 1971

1. DEPARTMENTAL PROFITS

LOCKHEED	-	£302,500
GIRLING		£ 80,500

2. DEPARTMENTAL SALES

LOCKHEED		£627,000
GIRLING		£466,000

3. DEPARTMENTAL COSTS

LOCKHEED	-	£929,500
GIRLING		£385,500

6.1 DEPARTMENTAL VARIABLE COSTS.

	LOCKHEED '71	GIRLING '71
DIRECT MATERIALS	£86,300	£28,123
DIRECT LABOUR	£229,536	£71,212
INSPECTION LABOUR	£57,771	£18,458
IND. PROD. LABOUR	£50,735	£26,602
IND. INSP. LABOUR	£27,401	£8,323
NAT. INSURANCE	£17,256	£4,757
GRAD. PENSION	£8,376	£3,126
HOLIDAY PAY	£27,065	£9,304
EMP. LIAB. INSURANCE	£1,782	£487
STORES Etc.	£23,827	£5,878
POWER	£11,868	£10,362
HEAT AND STEAM	£8,920	£4,134
WATER	£2,469	£581
PLANT MAINT. - MATERIALS	£34,281	£5,693
- LABOUR	£65,724	£23,840
MOULD MAINT. - MATERIALS	£7,276	£47
- LABOUR	£14,778	£13,429
TOTAL	£675,388	£234,350

6.2 DEPARTMENTAL FIXED COSTS.

	LOCKHEED '71	GIRLING '71
A. FIXED MANAGEMENT COSTS.		
MANAGEMENT	£47,147	£25,991
SITE	£8,670	£6,190
PERSONNEL	£16,473	£11,720
ADMIN. EXPENSES	£3,700	£2,640
STORES	£5,530	£920
IND. ENG.	£10,480	£7,800
TECHNICAL	£13,080	£9,350
DIV. COST	£15,440	£13,650
WORKS ACCOUNTING	£10,000	£7,920
MILL EXPENSES (ALLOC.)	£9,968	£3,150
	£140,488	£82,911
SALES	£10,059	£6,892
DIV. EXPENSES	£9,700	£6,900
ADVERTISING	£1,050	£750
	£21,009	£14,542
B. FIXED COSTS.		
ALTERATIONS	£1,000	£1,500
AMMORTISATION OF FIX. ASS.	£3,314	£297
DEPRECIATION	£74,381	£26,000
SECURITY	£1,403	£190
INSURANCE	£2,200	£1,550
ALLOC. MILL FIXED COSTS	£3,886	£7,688
RATES	£1,135	£7,110
TOTAL	£255,896	£141,788

6.3 SUMMARY OF ASSETS.

	LOCKHEED '71		GIRLING '71	
A. CURRENT ASSETS.				
STOCKS	£95,000		£44,000	
DEBTORS	£182,000		£113,000	
CREDITORS	(£98,000)		(£34,000)	
	£179,000	(£277,000)	£123,000	(£157,000)
B. CURRENT ASSETS.				
LAND and BUILDINGS	£90,000			
PLANT and MACHINERY	£157,000		£119,000	
GENERAL	£22,000			
MOULDS	£45,000		£9,000	
MILL	£18,000		£8,000	
LEASES	£4,000		£1,000	
	£341,000		£137,000	
TOTAL OPERATING ASSETS.	£520,000	(£618,000)	£260,000	(£294,000)

APPENDIX 'D'

1. Details of Estimated Savings of Implementation Projects in the Profit Improvement Programme.

2. Details of the Programme.

3. The G antt Activity Chart.

1. As evaluated in Appendix 'A'.

2,3,4,5,6, - These five projects were divided into two sections, those concerning auto-lathes, and those concerning hand lathes.

A. Auto-Lathes

There were four interrelated projects on 'autos' namely numbers 2,3,5 and 6.
In broad terms the output of the section was to be increased, and sustained by the introduction of new work and an incentive scheme. The evaluation of these projects was covered in a general fashion as follows :-

PROS.

1. The output of the auto-lathe section will be increased.
2. The total labour costs of the section will be reduced.
3. The transfer of parts from hand lathes will reduce the number of hand lathe operators.

Facts Required.

1.1. Present output from the section = 69,400 parts per day from three men working three machines for 24 hours.

1.2.1. Under new incentive conditions with one man operating four machines the output from three men working 24 hours would rise to approx. 157,000 parts per day.

The estimated increase in output results from :-

(i) Increasing the number of machines operated from 3 to 4.
(ii) Increasing the speed of operation of the machine from approx. 960 parts per hour to approx. 1,640 parts per hour.

(These figures were produced jointly by the author and Industrial Engineering Department).

1.2.2. However it was estimated that sufficient work could only be found to sustain two shift working.

i.e. The estimated output under new conditions would be approx. 105,000 parts per day.

2.1. Present labour costs of the section are three men @ £2,100 p.a. = £6,300 p.a.

2.2. Labour cost of proposed section would be two (2) men @ £2,100 p.a. = £4,200 p.a.

2.3. Reduction in labour costs = £2,100 p.a.

3.1. From figures in 1.2.2. the through put of the hand lathe section could be reduced by approx. 35,000 parts per day (105,000 - 69,400).

3.2. The average output from the hand lathe section is approx. 100,000 parts per day from 18 operators, i.e. approx. 5,500 parts per day per operator under the existing incentive conditions. However, the Industrial Engineering Department have estimated that on completion of the auto lathe projects the incentive scheme will have been introduced on the hand lathe section, and therefore the output is likely to be approx. 7,800 parts per day per operator. Therefore the saving in female lathe operatives is likely to be 4 operators (4 x 7,800 = 31,200 parts).

Note: Evaluation in this way eliminates the possible double counting of savings.

3.3. The average cost of a female hand lathe operator = £1,350 p.a.

3.4. Therefore the cost saving = £5,400 p.a.

Total savings = £2,100 + £5,400 p.a. = £7,500 p.a.

CONS

1. The average wages paid to the auto-lathe operators will increase under the new incentive conditions.

2. Costs will be incurred in improving the auto-lathes.

Facts required.

1.1. Under the conditions of the new incentive scheme, it has been calculated that the earnings of the auto-lathe operators will rise by approximately 25%. i,e, approx. £500.

1.2. Therefore the wages paid to the auto-lathe section will increase by approximately £1,000 p.a. (.2 x £500) under incentive conditions.

Cost of increased wages resulting from the incentive scheme = £1,000 p.a.

2. The Process Engineer responsible for the improvements projects estimated the cost of improving the machines at approx. £100.

B. Hand Lathe Projects.

There were three interrelated projects for hand lathes, namely numbers 4, 5 and 6.
As mentioned in Chapter 9 three new double cut lathes had been purchased, an incentive scheme was required for them, and in view of this requirement it was decided to cover all hand lathes with a new incentive scheme. The 3 old double cut lathes were being improved to standard of the new machines, so that they could be covered by the same incentive scheme.
Again the evaluation was performed in a general fashion as follows :

PROS.

1. The output of the section will be sustained with a reduced labour force, therefore at a reduced cost.

Facts required.

1.1. Present output from the section is as follows :
Total output = approx. 98,000 parts per day from 12 single cut, 3 old double cut and 3 new double cut hand lathes (Some double cut work being performed as two single cut operations on hand lathes).

Average output figures on :

(i) Single cut lathes approx. 5,600 parts per day.

(ii) Double cut lathes approx. 5,100 parts per day.

1.2. The incentive scheme will increase the output per machine by approx. 40%.

1.3. To sustain the schedule of 98,000 parts per day the following manning will be required under incentive conditions :
7 single cut lathes @ approx. 7,800 parts per day.
6 double cut lathes @ approx. 7,200 parts per day.

1.4. Therefore the manning levels should be reduced by 5 operators.

1.5. The average cost of a hand lathe operative is £1,300 p.a.

1.6. The total saving from implementation of the scheme = £6,500 p.a.

CONS

1. The introduction of an incentive scheme may result in an increase in operators wages.

2. The cost of improving the old double cut lathes, and provision of various small pieces of equipment for the incentive scheme.

Facts Required.

1. Industrial Engineering Department have calculated that existing rates are sufficiently 'slack' to allow the introduction of the scheme without an increase in earnings. This has been provisionally confirmed with union representatives.

2.1. The cost of improving the old double cut lathes has been estimated by the Engineering Department at £265.

2.2. The cost of providing the additional equipment has been estimated by the Process Engineering Department at £500.

Therefore the total net saving = £6,500 p.a.

(with a capital expenditure of £755).

Finally the total effect of both auto and hand lathe projects reduces the manning in the hand lathe section by 9 operators. At present in the section, there is one leading hand responsible for each 6 operators, therefore we have a further saving, that of the cost of a leading hand namely £2,000 p.a.

The total net saving of the 5 projects is £15,000 p.a.

(Estimated capital expenditure £865).

8. Design and implementation of an incentive scheme for cord production on the Barwell.

Estimated Savings : £3,000 p.a.

PROS

1. Reduction of the total labour cost of the Barwell section.

Facts required.

1.1. Present working of the section is 2 men per 8 hour shift working 3 shifts per day, i.e. 240 man hours per week, plus up to 30 man hours overtime per week.

1.2. Proposed working of the section under incentive condition would be 2 men per 10 hour shift working 2 shifts per day, i.e. 200 man hours per week, with no further overtime.

1.3. Therefore, it is anticipated that savings would amount to approx. 70 man hours per week.

1.4. Average wages paid in the section are approximately £1.10 per hour.

1.5. Therefore the total savings are equal to £1.10 x 70 x 48 (weeks p.a) = £3,680 p.a.

CONS

1. Increase in individual earnings of the remaining workers.

Facts required.

1.1. The shift allowance for operatives working a two 10-hour shift system was likely to be higher than the existing allowance.

1.2. The average earnings calculated on an expected agreed scheme could increase earnings by up to 5% depending on the mix of the work.

1.3. In all the Industrial Engineering Department has calculated that the earnings of individual operatives could rise by £3.50 per week. But this figure would depend on the outcome of negotiations with the unions.

1.4. Therefore the estimated total cost of increased earnings resulting from the scheme =

4 (operators) x £3.50 x 48 = £672 p.a.

. The estimated net savings of the project is
£3,000 p.a. (£3,680 - £672).

10. Elimination of the Stoning and Drilling Section.

Estimated saving (approx) : £3,000 p.a.

An initial attempt at evaluating this project indicated that an exact evaluation would be extremely time consumming. There were approx. 70 different parts of varying schedules requiring either stoning or drilling operations. However, 14 of these parts accounted for 70% of the total work load of the section.
Therefore after discussions with the Senior Process Engineer, it became apparent that the section would not be eliminated totally. More realistically the work force would be reduced by approximately two thirds.

PROS.

1. Reduction in labour costs.

Facts required.

1.1. Present labour situation in the section:
6 female operators earning approx. £1,450 p.a. each.

1.2. Anticipated situation (Two thirds reduction) :
2 female operators also earning approx. £1,450 p.a. each.

1.3. Estimated labour saving = £5,800 p.a.

CONS

1. The costs of eliminating the stoning and drilling operation.

Facts required.

1. Most of the 14 parts under initial consideration appeared to be undergoing the operations because of deterioration in the moulds.

Therefore it was anticipated that this would be largely a mould refurbishment project. Without detailed investigation a figure of £200 per part was estimated as the cost of refurbishment.

Total cost = £2,800 p.a.

(This was assumed to be an annual cost since it was assumed that the improvements must be maintained).

11. Replace Liq. CO_2 in the Wheelabrator with Liq. N_2

Estimated Savings = £140 p.a.

PROS

1. Savings in operator labour costs.

2. Savings in material costs.

3. Savings in maintenance costs.

Facts required.

1. Labour savings

Taking one operator working a 40 hour week as the basis for the operator labour savings.

Note:- No firm commitment can be given by production control as to the number of batches to be processed, so savings may be greater than estimated.

1.1. Saving in operator time as a result of reducing the process time by use of Liq. N_2.

- Operators day = 8 hours with a Rest Allowance of approx. 12%.

i.e. a total production time of 7 hours.

Liq. CO_2 cycle = Av. machine cycle time ($5\frac{1}{4}$ minutes).
+ Load/unload time (1 minute)
= $6\frac{1}{4}$ mins/cycle.

in 7 hrs. approx. 65 batches are processed.

Initial trials have indicated that the Liq. N_2 process will produce a cycle 15% shorter than Liq. CO_2.

i.e. a saving of $\frac{15}{100} \times 65 \times 5\frac{1}{4}$ minutes per day

= 51 minutes per day = 17 hrs. per month.

1.2. Spin-off labour savings.

1.2.1. The use of Liq. N_2 should reduce the monthly defrost operation from approx. 6 hours to 3 hours.
i.e. A labour saving of 3 hours per month.

1.2.2. The use of Liq. N_2 will also reduce the "start-up"/"cool-down" period. This period normally lasts $3\frac{1}{4}$ hours per week and should be reduced to approximately 15 minutes.
i.e. A labour saving of 12 hours per month.

1.3. The total operator labour saving = 32 hours per month @ approx. £0.72 per hour.
= £23 per month.

2. Savings in material costs

2.1. The cost of Liq. CO_2 required to process a batch of work = 22.82p.
2.2. The cost of Liq. N_2 required to process a batch of work = 21.92p.
(These figures were obtained from a report produced by Air Products Ltd).
2.3. On the assumption that 65 batches are processed each day.
The total saving in refrigerant costs
= 65 x 0.9p. x 20 = £11.70 per month

2.4. <u>'Spin-off'' material savings</u>

2.4.1. Due to expected reductions in condensation the amount of absorbent material used during the monthly defrost operation will be reduced from 2 bags to 1 bag - (Estimated by Eng.Dept).

<u>Saving 1 bag of 'Sorb-oil' = £2.50 per month.</u>

2.5. <u>Total material savings = £14.20 per month</u>

3. <u>Savings in maintenance costs</u>

3.1. The Engineering Department have estimated that reduced condensation will reduce the engineering time spent clearing sticking valves.

<u>Estimated saving in engineering labour = 8 hrs per month.</u>

3.2. The fact that Liq.N_2 is a non-toxic gas will also mean that when an engineer enters the freezing cabinet, there will be no need to provide a second engineer for safety reasons.

<u>Estimated saving in engineering labour = 4 hrs. per month.</u>

3.3.1 The average cost to the Lockheed Department of Engineering labour is £2.00 per hour.

3.3.2 <u>The total maintenance savings = £24 per month.</u>

Therefore the total savings are £23 + £14.20 + 24 = <u>£61.20 per month.</u>

<u>CONS</u>

1. Cost of renting a liquid nitrogen storage tank.

2. Cost of installing the tank.

<u>Facts Required.</u>

1.1. The rental charge for a Liq.N_2 tank = <u>£50 per month.</u>

1.2. There is no rental charge for the existing Liq.CO_2 tank as it is owned by the company, indeed it could be sold to cover the cost of installation of the rented tank..

2.1. <u>Estimated costs of installation of Liq.N_2 tank = £350.</u> (This may be recovered see 1.2. above).

<u>Total Cost = £50 per month</u>

<u>Estimated Net Saving = £61.20 - £50 per month.</u> = <u>£140 p.a.</u>

16. Design and implement an incentive for the Edgwicks following the completion of projects 13 and 14.

Estimated Savings : £15,000 p.a.

PROS.

1. The total number of operatives and therefore the total labour costs of the edgwick section will be reduced.

Facts Required.

1.1. Present situation :

30 male direct operatives employed at a cost of £1,900 p.a. each.
In addition the section has :

i. 3 relief operators earning the average of the section. i.e. £1,900 p.a.

ii. 9 leading hands, who set-up the machines.

1.2. Anticipated situation under incentive conditions, (although the scheme has not been finalised).

21 male direct operators employed at the same average cost. (plus the additional labour as above).

1.3. Therefore the estimated saving in labour costs = 9 x £1,900 p.a.
= £17,700 p.a.

CONS

1. Operators earnings may rise as a result of the incentive scheme.

2. The scheme will require the machines to be moved to allow 1 man the facility to operate 3 machines.

Facts Required.

1. The Industrial Engineer responsible for producing and implementing the scheme felt sure that it would be introduced without increase in earnings.

2. The cost of moving the machines was likely to be approx. £3,000, but the final cost will depend upon the details of the finalised scheme. Also it was possible that this work would be performed on the departments maintenance budget so that it would not necessarily be considered as capital expenditure.

Therefore in view of the above, and the element of doubt about the exact labour savings, which could not be evaluated until the scheme was nearer finalisation, the savings were estimated at approx. £15,000 p.a.

22. Investigate the possibilities for regrouping the Finishing Department into smaller units - (as evaluated in Appendix (A). Estimated Savings = £27,000 p.

23. Investigate the possibilities of replacing cardboard packing cases with polythene bags.

Estimated Savings : £350 p.a.

PROS.

1. Savings in the cost of packaging materials.

Facts Required.

1.1. Cost of existing packaging materials. The Buying Department records indicate the annual usage of materials as :

(i) 5,000 12" x 12" x 12" boxes @ £48.82 per 1,000 = £229

\+ (ii) 40,000 18" x 18" x 12" boxes @ £94.80 per 1,000 = £3,792

= £4,021 p.a.

1.2. Cost of polythene bags to replace the boxes (Estimated by the Buying Department).

(i) 15,000 24" x 24" bags @ £12 per 1,000 bags = £180 p.a.

\+ (ii) 160,000, 32" x 30" bags @ £21.80 per 1,000 bags = £3,490 p.a.

= £3,670 p.a.

1.3. Estimated saving = £4,021 - £3,670 = £351 p.a.

CONS

1. The customer may not agree to parts being supplied in polythene bags.

Facts Required.

1. Having established that savings are attainable the customer must now be approached.

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT	TARGET DATE
1. Convert Compression parts to Injection Parts where possible, and monitor savings.	£39,000	P.C. - T.Quinn	COMPLETE
2. Determine those hand lathe parts which can be produced on the auto lathes.	)	P. - F.Cave P.E. - P.Smith	26.1.73
3. Implement the recommendations on improving the reliability of auto lathes.	)	P.E. - P.Smith	23.2.73
4. Improve the old double cut lathes	)	P.E. - A.Hughes I.E. - A.Pritchard	26.1.73
5. Determine the optimum life of a lathe knife	) £15,000	P.E. - P.Smith	5.1.73
6. Design incentive schemes for all lathes	)	I.E. - A.Pritchard	23.2.73
7. Determine the best method of producing blanks and cord using a collectacool, and batching mechanism.	) £3,000	P.E. - J.Pitcher	16.2.73
8. Design an incentive schem for cord production		I.E. - D.Day	22.12.72
9. Determine those parts whose process specifications do not agree with the present technical drawings, update the specifications and ensure/check that the new specifications are adhered to.		T. - K.Watts	29.12.72 + random monitoring
10. Eliminate the stoning and drilling section.	£3,000 p.a.	P.E. - J.Pitcher	20.7.73

<u>KEY:</u>

P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT.	TARGET DATE.
11. Replace Liq. CO_2 in the Wheelabrator with Liq.N_2	£140 p.a.	P. - M.Foy	26.1.73
12. Examine the possibility of compound APR.1000 replacing compounds 1701,1702 and 1707, also the possible development of a compound to replace 1784		T. - K.Watts	Prod.Samples January 1973.
13. Evaluate the minimum acceptable cure times for parts produced on all moulding machines.		T. - K.Watts	
14. Determine the stripping time method for Edgwick parts.	See 16	I.E. - J.Styler	17.12.72
15a. Determine the content of all moulding machine downtime, and evaluate the possible savings from reducing it.		P. - M.Foy E. - A.Glease	26.1.73
15b. Reduce moulding machine downtime			2.3.73
16. Design a payment scheme to conincide with improvements resulting from projects 13,14 for press operatives.	£15.000	I.E. - J.Styler	2.3.73
17. Design a payment scheme to conincide with changes in finishing operatinns resulting from Projects 9, 12, (18?).		I.E. - D.Day	
18. Evaluate the possibility of improving the 'Clicking' machinery.		P.E. - A.Hughes	26.1.73
19. Evaluate the information gained from Projects 13, 14, and 15 with a view to improving the work scheduling system.		P.C. - T.Quinn	20.7.73

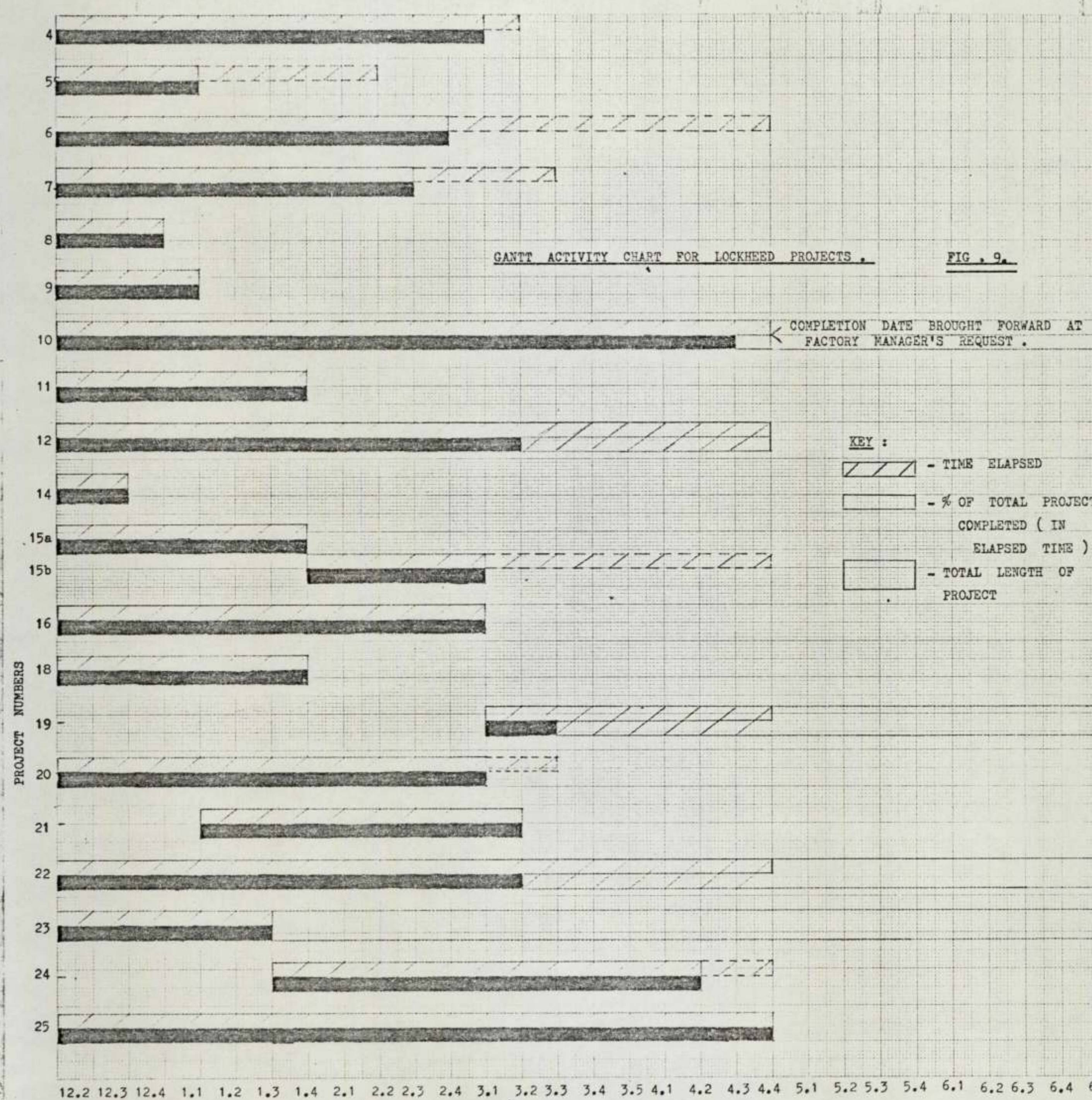
<u>KEY :</u>

P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL

PROJECT	PRELIMINARY EVALUATION	RESPONSIBILITY FOR PROJECT	TARGET DATE
20. Determine the economical batch size		P.C. - T.Quinn	2.3.73
21. Produce the best bench layouts and inspection work conditions in accordance with Birmingham University recommendations.	Awaiting report	I.E. - A.Pritchard	Awaiting Report
22. Investigate the possibilities for regrouping the Department into smaller units.	£27,000 p.a.	J.R.Bainbridge	20.7.73
23. Investigate the possibilities of replacing cardboard packing cases with polythene bags.	£350 p.a.	P. - G.Stockell	29.6.73
24. Design a payment scheme to coincide with improvements resulting from Project 21.	Awaiting Report.	I.E. - A.Pritchard	Awaiting Report
25. Examine E.P.D.M. compounds and their possible introduction into the Lockheed Department.	?	T. - K.Watts	1974

<u>KEY:</u>

P. - PRODUCTION
P.E. - PRODUCTION ENGINEERING
I.E. - INDUSTRIAL ENGINEERING
E. - ENGINEERING
T. - TECHNICAL



GANTT ACTIVITY CHART FOR LOCKHEED PROJECTS . FIG . 9.

APPENDIX E

MONTHLY SCHEDULES AT 1971 AND 1973 PRICES

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
112	S	1.175	2,200	26	5,200	61
131	S	1.020	49,000	500	32,000	326
132	B	1.845	2,000	37	1,500	27
212	S	1.383	2,400	33	2,400	33
232	B	5.810	800	46	-	-
260	B	5.191	500	26	1,400	73
332	B	1.677	10,000	168	10,000	168
400	S	1.404	3,500	49	5,000	70
437	B	3.581	8,000	286	9,000	322
539	S	1.780	10,000	178	6,000	107
544	B	7.960	-	-	100	8
563	S	4.070	-	-	8,500	346
586	S	0.956	-	-	15,000	143
588	S	1.037	32,000	332	20,000	207
678	S	45.010	100	45	-	-
698	S	4.987	7,000	349	14,000	698
750	S	9.025	500	45	200	18
921	B, [illegible]	30.000	100	30	100	30
928	B	60.000	20	12	20	12
1277	S	1.314	10,000	131	2,200	29
1668	B	1.640	1,200	20	800	13
1671	B	6.367	600	38	400	25
2759	B	6.300	-	-	500	32
2762	S	1.747	13,000	227	10,000	175
3008	S	1.483	2,500	37	3,000	44

KEY : - S - SEALS

B - BOOTS

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
3030	B	23.820	300	71	500	119
3590	S	1.984	1,000	20	1,300	26
5632	B	6.480	-	-	250	16
6042	S	8.200	2,000	164	2,500	205
6935	S	9.630	500	48	300	29
8617	S	18.205	200	36	-	-
8831	S	2.552	700	18	1,000	26
8832	S	3.086	500	15	2,500	77
9503	S	2.162	3,500	76	1,000	22
9913	S	2.580	200	5	100	3
9964	S	8.020	150	12	-	-
10220	S	1.908	400	8	2,000	38
10799	S	2.141	13,000	278	20,000	428
12046	S	1.613	12,000	194	5,000	81
12493	B	12.3	-	-	-	-
12822	S	1.980	2,500	50	3,000	59
14562	S	1.951	13,000	258	11,500	224
15262	S	5.325	300	16	-	-
19856	B	32.302	20	6	20	6
21096	S	2.428	2,000	49	-	-
21740	B	18.740	-	-	1,000	187
22309	B	2.660	12,000	319	11,000	293
22955	B	12.712	-	-	300	38
23372	S	11.170	100	11	50	6
24950	S	1.161	10,000	116	10,000	116
24951	S	18.022	-	-	150	27

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
24953	S	6.400	300	16	400	26
24959	B	25.112	-	-	-	-
24960	B	34.225	200	68	-	-
24961	B	7.020	500	35	800	56
24972	B	13.337	-	-	300	40
24975	B	18.350	100	18	-	-
24978	B	9.940	700	70	500	50
24990	B	30.725	-	-	50	15
24995	B	21.250	300	64	800	170
25000	S	4.348	3000	130	-	-
25003	S	10.800	400	43	-	-
25004	S	10.720	300	32	-	-
25014	S	5.290	-	-	1000	53
25228	B.	25.100	400	100	50	13
25387	S	2.236	-	-	300	7
25514	S	1.099	-	-	9000	99
25825	S	2.450	2200	54	2500	61
27088	B	38.954	200	76	50	19
27517	S	11.180	-	-	1000	112
27520	S	1.351	4000	54	-	-
27522	S	2.678	-	-	2000	54
27525	S	1.656	1400	23	2000	33
27526	S	1.001	100000	1001	125000	1251
27676	S	5.380	300	16	300	16
27678	S	1.528	-	-	1200	18

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
27867	B	1.528	12000	531	18000	275
27977	S	1.659	2300	38	200	33
28112	S	1.353	2600	35	3000	41
28780	B	27.254	200	55	-	-
29578	B	2.210	3500	77	4500	99
29621	B	21.200	-	-	400	85
29630	B	8.141	2500	204	2800	228
29779	S	4.354	1800	78	2000	87
30632	B	8.450	-	-	1000	85
30832	S	7.070	200	14	200	14
30849	S	N/A	200	-	-	-
31010	B	8.272	800	66	1000	83
31118	S	0.750	17700	1327	360000	2700
31176	B	1.711	2500	43	2500	428
31250	S	1.399	1600	22	2500	35
31329	S	N/A	600	-	-	-
32168	S	11.640	1000	116	500	58
32296	B	2.996	700	21	1600	48
32548	S	6.145	100	6	-	-
32610	S	0.825	15000	124	10000	83
33348	B	8.010	4000	320	1200	96
33427	B	1.726	56000	967	66000	1139
33743	B	3.288	4000	131	8000	263
34889	S	11.562	900	14	1500	173
35415	B	50.400	600	302	1000	504
37121	S	6.140	200	12	-	-

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
37374	S	1.738	88000	1529	-	-
37741	B	38.250	-	-	250	96
38182	B	1.313	9000	118	3800	50
38253	B	2.673	11000	294	-	-
38539	S	7.500	-	-	13500	1013
38545	S	6.150	300	18	-	-
39057	B	22.500	700	157	300	68
39325	B	2.054	1200	25	2500	57
39558		N/A	300	-	-	-
39508	B	4.440	300	13	-	-
39509	S	2.220	400	9	-	-
80416	B	4.455	13000	588	9500	425
81110	B	27.80	400	111	-	-
39994	B	0.913	78000	712	36000	340
81124	S	1.088	72000	783	110000	1197
81766	S	2.111	1000	22	2000	44
81791	B	28.111	100	28	-	-
82482	B	6.432	-	-	150	10
82536	S	22.176	50	11	400	89
83913	S	1.013	26000	263	26000	263
83173	S	1.657	600	10	1200	20
84900	B	8.956	200	18	1000	90
85422	B	1.171	50000	585	-	-
87071	S	0.850	185000	1572	210000	1785
87143	S	2.541	5000	127	12000	305

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
87227	S	18.332	200	37	-	-
87366	S	1.811	48000	869	30000	543
87439	B	1.697	2700	46	3500	59
89576	B	1.688	-	-	2000	34
90258	B	2.700	100	27	100	27
90598	S	0.721	1000	7	15000	108
92130	S	6.350	50	3	0	-
92328	S	1.885	1000	18	300	6
93871	B	9.100	-	-	3000	273
94713	S	2.365	750	18	350	828
97855	S	3.954	600	24	200	8
97913	S	6.280	100	6	-	-
97914	S	6.260	100	6	-	-
98796	B	4.653	500	23	1500	70
99268	B	1.680	31000	521	35000	588
100341	S	0.846	60000	508	35000	296
101546	S	1.140	30000	342	38000	433
102509	S	0.796	37000	2523	40000	350
102965	S	7.280	100	29	300	22
104871	S	5.358	100	43	600	32
105671	B	5.920	200	12	1400	83
106213	S	26.100	600	157	1000	261
106646	B	3.222	300	10	1300	42
107126	S	0.892	100000	892	64000	571
108128	S	1.014	37000	375	34000	345
109826	S	1.391	12000	167	8000	111

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
109827	S	1.033	130000	1343	-	-
109828	S	2.050	-	-	-	-
102964	S	29.202	100	29	-	-
109829	S	5.560	400	22	100	6
109831	S	5.700	200	11	700	40
109833	S	5.420	500	27	1000	54
109882	S	1.919	3000	58	4000	77
110126	B	44.700	300	134	-	-
112273		7.620	50	4	-	-
112536	B	6.030	400	24	200	12
113190	S	3.050	-	-	-	-
3667-438		4.970	700	34	-	-
3811-726	B	8.351	-	-	400	33
3812-428	B	2.440	240	6	2500	61
430	B	2.119	60000	1271	35000	742
717		1.795	240	4	-	-
722	S	21.134	200	42	1900	42
728	S	2.292	4800	110	4000	92
730	B	3.079	480	15	600	18
733	B	4.058	4200	138	6000	243
736	S	11.220	800	90	12000	1346
737	B	1.523	70000	1066	80000	1218
738	B	1.330	300000	3990	400000	5320
739	B	11.700	100	12	-	-
741	B	2.691	16000	431	-	-

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
3813-711	B	4.180	4800	201	1500	63
713	B	2.716	25000	679	20000	543
714	B	4.226	7000	296	2800	118
3815-444	B	80.500	100	80	100	81
733	B	8.778	2000	175	1600	140
734	B	8.1	1000	81	1000	81
737	B	7.633	200	15	-	-
742	B	7.786	9000	701	15000	1168
3817-715	B	2.650	10000	265	16000	424
724	B	80.000	-	-	-	-
725	B	1.963	1440	28	1500	29
732	B	5.775	1200	69	2400	138
737	B	1.394	-	-	-	-
3818-415	D	14.494	-	-	15000	2200
735	D	23.104	600	139	-	-
736	D	21.403	600	128	1000	976
3842-424	S	0.976	65000	634	100000	976
430	S	1.117	1000	112	-	-
622	S	5.500	800	44	-	-
623	S	1.524	2200	33	10000	152
626	S	2.230	-	-	5000	111
447	S	1.579	31000	489	50000	790
3852-431	S	1.723	3000	52	-	-
3854-751	S	2.771	4000	111	4000	63
3862-423	S	2.977	560	17	1000	30
435	S	2.473	800	20	1000	25

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
3865-740	S	3.720	1000	37	6400	238
3866-423	S	2.080	10000	208	15500	322
3871-424	S	1.436	34000	488	-	-
427	S	1.333	560	7	4000	53
431	S	1.299	-	-	100000	1299
448	S	3.763	7000	263	26000	978
451	S	5.117	1400	72	-	-
464	S	25.336	100	25	-	-
474	S	1.750	1200	21	-	-
475	S	2.371	400	10	1200	28
422	S	6.060	-	-	500	30
723	S	6.020	600	36	400	24
730	S	7.537	400	30	4000	301
3872-418	S	2.911	600	17	-	-
424	S	8.544	-	-	400	34
713	S	8.55	-	-	1000	86
3873-413	S	1.336	12000	160	15000	200
415	S	2.311	2000	46	-	-
422	S	2.063	28000	579	26000	536
715	S	2.311	100	2	-	-
3874-411	B	8.000	200	16	100	8
419	S	2.756	1000	28	-	-
3875-422	S	2.984	-	-	500	15
429	S	1.597	10000	160	18000	287
716	S	7.167	780	56	800	57
719	S	9.271	2000	185	-	-

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
3875-722	S	8.021	1200	96	-	-
3876-413	S	9.500	1200	90	-	-
415	S	2.059	45000	927	37000	762
740	S	5.917	600	36	-	-
715		8.330	400	33	500	42
J 293	B	6.188	1000	62	1500	93
J 530	B	4.066	150	6	2000	81
J 3177	B	2.100	3300	69	2000	42
J 4025	B	1.929	3300	64	5500	106
J 6195	B		-	-	-	-
V 7185	B	5.750	150	9	-	-
J 7400	B	1.733	400	7	500	9
J 7853	B	2.355	5000	118	5500	130
J 7870	B	1.984	3300	65	2000	40
J 7998	B	1.249	3300	41	4800	60
J 8039	B	2.074	3750	78	3400	71
J 8043	B	2.304	5000	115	1500	35
J 8110	B	1.967	13000	256	10000	197
J 9562	B	3.408	2000	68	2000	68
J 9989	B	2.674	3000	80	-	-
H 11592	B	9.171	900	83	1500	138
H 12281	B	2.275	200	5	200	5
V 12368	B	2.331	1000	23	2000	47
V 13057	B	2.207	10000	220	6000	32
J 13463	B	4.230	300	13	-	-
J 13490	B	2.810	2000	56	500	14

Part No.	Type of Part.	Selling Price Per 100 1971 (£).	Mthly. Sched. Parts. 1971.	Sales Value of Sched. 1971 (£)	Mthly. Sched. Parts. 1973.	Sales Value of Sched. 1973 (£)
J 13491	B	2.555	1300	33	2000	51
J 16008	B	18.250	400	73	-	-
J 16011	B	27.000	200	58	-	-
J 16013	B	2.473	1000	25	.160	4
J 16015	B	3.189	20000	638	19500	622
J 16035	B	11.134	1200	134	300	33
V 19161	B	1.684	-	-	25000	421
J 19175	B	1.446	-	-	1000	14
J 19186	B	1.920	5000	96	6000	115
J 19187	B	1.847	11000	203	15000	277

APPENDIX F

PRESENTATION - I.H.D. WORK AND CHANGES
IN THE LOCKHEED DEPARTMENT
1971 - 1973.

PRESENTATION ON I.H.D. RESEARCH WORK

AND CHANGES IN THE LOCKHEED DEPARTMENT

DURING THE PAST TWO YEARS.

PRESENTED BY :	J.R. BAINBRIDGE	
PRESENTED TO :	MR. D.A. AIR	MANAGER, SKELMERSDALE.
	MR. G. STOCKELL	PRODUCTION MANAGER.
	MR. T.B. TATE	SNR. VISITING LECTURER, ASTON UNIV.
	DR. A.J. COCHRAN	I.H.D. TUTOR

28th September 1973.

PURPOSE OF THE MEETING.

1. To review changes in the Lockheed Departmental financial situation, and the reasons for the improvements.

2. To review the part project work played in the improvement of the overall situation of the Department.

3. To review the techniques introduced as part of the I.H.D. work.

4. To decide on a programme of work for the final year of I.H.D. research.

LOCKHEED DEPARTMENT GENERAL FIGURES.

	1971.	1972.	1973.
GOOD O/P	37.9m	32.8m	38.5m
SALES T/O. (incl.MISC.INCOME)	£627,000	£678,800	£895,000
TOTAL COSTS	£943,000	£813,500	£866,000
PROFIT/LOSS	(£316,000)	(£134,700)	£ 29,000
TOT.NO.OF EMP.	306	248	210
% SCRAP (ON GOOD)	44%	36.6%	28%

LOCKHEED DEPARTMENTAL ACCOUNTS.

		1971(1000's)	1972(1000's)	1973(1000's)
LABOUR (incl.MAINT. + FRINGE BEN.)		460	378	402
MATERIALS		86	85	92
MAINTENANCE MATERIALS		40	25	26
POWER		23	26	27
	DIR. COSTS SUB.TOTAL	609	514	547
FIXED COSTS		334	300	319
	TOTAL COSTS	943	814	866
TOTAL REVENUE		627	679	895
PROFIT/LOSS		(316)	(135)	29
(SCRAP COSTS (incl. above)		160	126	105)

POSSIBLE REASONS FOR IMPROVEMENT ARE CHANGES IN THE FOLLOWING:

- Volume..
- Product Mix.
- Prices.
- Material Cost.
- Projects.
- Organisational Changes.
- Morale.

1.1. EFFECTS OF CHANGES IN VOLUME.

	1971.	1972.	1973.
TOTAL GOOD PARTS SOLD	37.92m.	32.81m.	38.5m.

Comparing 1971 sales with 1973 sales the change in volume is negligible.

1.2. PRODUCT MIX CHANGES.

	1971	1973.
Mthly Sched.	2.86m.	3.24m.
Value of Sched. at 1971 Prices.	£44.900	£57,500
% Seals	68.6% = 1.96m.	70.3% = 2.27m.
Value of Seals T/O. (at 1971 Prices).	£23,800	£35,300
% Boots	31.4% = 0.90m.	29.7% = 0.95m.
Value of Boots T/O. (at 1971 Prices).	£21,100	£22,200

NOTE:

The average price of parts rises from £1.57 per 100 (1971) to £1.79 per 100 (1973).

Reason -

Due to change of product mix of seals. Increase in T/O of higher priced seals.

Value of change in mix of seals is worth an increase of £120,000 p.a. on 1971 Sales T/O.

1.3. CHANGES IN PRICE.

	1971.	1972.	1973.
No. of Parts Sold	37.92m.	32.81m.	38.5m.
Sales T/O	£579,000	£640,000	£860,000*
Av. Selling Price (per 10^2)	£ 1,527	£ 1,951 (£ 1,768)	£ 2,236

(* Forecast figure for meeting a full schedule).

1972 PRICE NEGOTIATIONS:

- Value of increase on 1972 T/O = £60,250
- Approx. value of increase on 1973 T/O = £160,000

NOTE:

(It is likely that a yearly price increase would have been negotiated even if the 25% had not.)

(e.g., Price rise 1971/72 = 15% before 25%).

1.4. MATERIALS COSTS:

Unprocessed Materials Costs have remained almost constant.

c.f. 1971 - £86,000 1973 - £92,000
(for a similar O/P)

If anything costing information shows a slight fall in raw material costs, offset by an increase in labour costs to give an almost constant V.W.C.

1.5. PROJECTS.

- With the exception of the mould conversion project, all project savings have an effect on 1973 financial figures.

- The total evaluated savings from the project programme to date are:

£91,950 p.a.

- These will be discussed in more detail later.

1.6. ORGANISATIONAL CHANGES AND IMPROVEMENTS IN MORALE.

		1971.		1972.		1973.	
Labour Figures		306		248		210	
	DIR.	81	148	75	106	64	82
	IND.	48	29	39	28	32	31
Ave. Earnings per Op.		£1,194 p.a.		£1,220 p.a.		£1,570 p.a.	
Value Added per Op.		£1,610 p.a.		£2,238 p.a.		£3,657 p.a.	

- Average earnings per operator have risen by £380 p.a. in 71/71 period, as a result of wages agreements, organisational changes, and incentive schemes.

- 1973 value added less the effects of price increase and change in product mix is £2,320 i.e., a rise of £710 on 1971 value.

1.7. GROSS ANALYSIS.

PROFIT/LOSS	Changes from	(£316,000) -	1971
	to	£ 29,000 -	1973

i.e., Equivalent to an increase in profit of

£346,00 p.a.

REASONS.

- Volume Change	=	0	
Mix "	=	+ £120,000 p.a.	
Price "	=	+ £180,000 p.a.	
Mat. Costs "	=	0	
Projects	=	+ £ 92,000 p.a.	
Organisation Changes	=	- £ 30,000 p.a. *	
(Scrap	=	+ £ 46,000 p.a.)	
(Wages	=	- £111,000 p.a.)	-*£30,000 p.a.
(Maint.	=	+ £ 20,000 p.a.)	
(Overheads	=	+ £ 15,000 p.a.)	

∴ NET CHANGE = + £342,000 p.a.

2. PROJECT PROGRAMME.

25 - Projects

3 Feasibility

10 Research

12 Implementation

Completed	:	15
Continuing	:	3
Awaiting further decisions/information	:	3
Rejected after further research	:	2
Failed	:	2

Total actual saving from project programme

= £91,950 p.a.

Total expected saving from the programme

= £106,700 p.a.

PROJECTS PROGRAMME.

2.1. FEASIBILITY PROJECTS.

- Determine the best method of material production.

- Examine the possible uses of APR.1000.

- Examine the possibilities of improving the clicking machinery.

2.2. RESEARCH PROJECTS.

1. Determine those hand-lathe parts which can be produced on auto-lathes.

2. Determine the optimum life of a lathe knife.

3. Determine minimum acceptable cure times.

4. Determine stripping time/method for Edgwick parts.

5. Determine content of downtime on moulding machines.

6. Examine the work scheduling system in view of changes arising from projects.

7. Determine E.B.Q's.

8. Investigate the possibility of re-grouping the Department into smaller units.

9. Investigate the possibility of replacing cardboard packing cases with polythene bags.

10. Examine E.P.D.M. compounds and their uses.

2.3. IMPLEMENTATION PROJECTS.

1. Convert compression parts to injection parts.

2. Implement recommendations for improving auto-lathes.

3. Improve the old double cut lathes.

4. Design incentive schemes for lathes.

5. Design an incentive scheme for cord production.

6. Update specifications.

7. Eliminate the stoning and drilling section.

8. Replace Liq. CO_2 with Liq. N_2 in the Wheelabrator.

9. Design an incentive scheme for the Edgwicks (1 man - 3 machines.)

10. Design incentive schemes for finishing areas affected by projects.

11. Implement Birmingham University recommendations for inspection working conditions.

12. Design an incentive scheme for Inspectors.

2.3.1. CONVERSION OF 16 COMPRESSION PARTS TO INJECTION PARTS.

Estimated saving = £39,000 p.a.

Actual saving = £37,200 p.a. (+ £14,000 p.a.)

SAVINGS: (FROM 13 PART NOS.)

Good quantity required	:	228,000 parts per month.
Inj. O/P to produce Sched.	:	280,620 " " "
Equ. Comp. O/P to produce Sched.	:	368,500 " " "

Materials saving = £ 7,500 - £ 4,150 = £ 3,350 p.a.

Labour saving = £52,200 - £18,400 = £33,800 p.a.

∴ TOTAL SAVING = £37,200 p.a.

- SPIN OFF SAVINGS.

- The conversions were a major factor contributing to the closure of the "Iddons" and certain Daylight Presses. These presses were incurring high maintenance costs.
  From Engineering estimates savings in maintenance costs are:

  ~ £14,000 p.a.

2.3. 2, 3, 4. LATHE PROJECTS.

Estimated saving - £15,000 p.a.

Actual saving - £16,300 p.a.

- Determine those hand lathe parts which can be produced on autos.
- Determine the optimum life of a lathe knife.
- Implement recommendations for improving autos.
- Improve the old double cut lathes.
- Design incentive schemes for lathes.

A. AUTO LATHES:

Related schemes

(1) Investigation for new parts.

(2) Improve output figures.

(3) Incentive Scheme.

SAVINGS AS A RESULT OF THE ABOVE:

	BEFORE.	AFTER.
O/P (per.day)	69,400	106,000
No.of Ops.	3 (1m x 3 m/c)	2 (1m x 4 m/c)
Ave. Wages	£6,300 p.a.	£5,200 p.a.

TOTAL ACTUAL SAVING ON AUTO-LATHE

LABOUR = £1,100 p.a.

Now we have a 53% increase in output from the section, (or 36,500 parts per day.) This is equivalent to the output of 4 hand-lathes or a labour cost of £5,400 p.a.

∴ SAVING ON HAND-LATHE LABOUR = £5,400 pa.

- SPIN OFF SAVING. (ANTICIPATED). £1,200 p.a.

- Due to increased O/P from section, female sorting uncut/misfeed parts unable to cope.

- Introduction of automatic sorting machines.

PROS.

1. Reduction of section labour force by 1 female operative.

SAVING £1,200 p.a.

CONS.

1. (Capital cost of machinery £440).

TOTAL SAVING FROM "AUTO" PROJECTS

£7,700 p.a.

B. HAND LATHES.

Related schemes

- Improve the old double cut lathes.

- Design incentive schemes for the lathes.

- Improvement of double cut lathes.

O/P increase FROM ~5,500 parts per day.
TO ~7,200 parts per day.

∴ Increase in O/P from 3 old double cut lathes

~5,100 = 1 hand lathe.

∴ SAVING = £1350 p.a. (1 operator).

(CAPITAL COST = £265).

INCENTIVE SCHEMES SAVING.

	BEFORE PROJECT WORK.	AFTER.
No. of Lathes	6 D/C - Double Cut.	6 D/C
	12 S/C - Single Cut.	7 S/C
	1 B/S - Back Stop.	1 B/S
O/P per day.	98,000	98,000
Operatives Wages	£24,700 p.a.,	£18,200 p.a.,

∴ TOTAL SAVING = £6,500 p.a.

However, £1,350 p.a., has been accounted for by improved O/P for the old D/C Lathes.

∴ NET SAVING FROM INCENTIVE SCHEME = £5,150 p.a.,

Also as a result of the reduction of the number of hand-lathe and drill operators, the number of leading hands in the finishing area has been reduced by 1.

SAVING £2,100 p.a.,

(CAPITAL COST OF INCENTIVE SCHEMES = £640.)

TOTAL SAVING FROM "HAND-LATHE PROJECTS

= £8,600 p.a.

2.3. 5. DESIGN OF INCENTIVE SCHEME FOR CORD PRODUCTION.

- Estimated saving = £3,000 p.a.

- Actual saving = £2,300 p.a.

SAVING

-	BEFORE.	AFTER.
Av. hrs. worked (per. week)	271	241
Av. wages (per week)	£303	£255

SAVING = £48 per week.

2.3.6. UPDATE SPECIFICATIONS:

- Estimated saving unknown.

- Project covered 100 part numbers, representing about 80% of the Schedule.

- Most important result - Part No. 39994 was being stoned, and this was not required.

SAVING:

Schedule = 55,000 good per month.

Scrap Rate = 27% .˙. Total = 70,000 parts

Stoning rate 14 mins. per 100 .˙. Total operator time per month = 163 hours.

.˙. SAVING = 1 OP. = £1,350 p.a.

(CAPITAL COST -0)

2.3.7. ELIMINATE STONING AND DRILLING SECTION.

- Estimated saving = £3,000 p.a.
- Actual saving = £4,400 p.a.

MANNING LEVELS.

BEFORE.	AFTER.
6 Ops. cost - £8,500 p.a.	2 Ops. cost - £2,700 p.a.

∴ GROSS SAVING = £5,800 p.a. (i.e. 4 OPS.)

However, due to "double-counting" we have claimed a saving of 1 operator in previous project.

∴ ACTUAL SAVING = £4,400 p.a. (i.e. 3 OPS.)

(ESTIMATED CAPITAL COST - £1,800)

2.3.8. REPLACE LIQ.CO_2 WITH LIQ.N_2 IN THE WHEELABRATOR.

- Estimated saving = £ 140 p.a.
- Actual saving = £2,000 p.a.

SAVINGS: (MONTHLY)

	CO_2		N_2
Refrigerant	£615		£495
		SAVING = £120.	
Operator Time	290 hrs.		180 hrs.
Start Up	12 hrs.		0
Defrost	6 hrs.		4 hrs.
		SAVING = 124 hrs. = £95.	
Extra Materials	£5.		£2.50p
		SAVING = £2.50.	
		TOTAL SAVING = £217.50p.	
Tank Rental	0		£50.
		NET SAVING = £167.50p. per mth. (= £2,000 p.a.)	

(CAPITAL COST = £363)

2.3.9. DESIGN A PAYMENT SCHEME FOR EDGWICKS.

(Incl. 1 man working 3 machines).

Estimated Saving = £15,000 p.a.

Actual Saving = £14,400 p.a.

SAVINGS:

	BEFORE:	AFTER:
No.of Dir.Ops.	30 M.	24 M.
Av.hours worked	1281	864
Av.wages paid	£1,171	£872

SAVING = £300 per week.

(CAPITAL COST OF MOVING MACHINES = £3,000)

2.3.10. <u>DESIGN PAYMENT SCHEMES TO COINCIDE WITH CHANGES IN FINISHING AREAS.</u>

- Most important changes were in the Laths Sections, but these schemes have already been evaluated.

- An incentive scheme has been introduced on the Roller Trim Section, resulting in an increase in output, but at increased cost.

Savings were therefore negligible.

2.3.11. IMPLEMENT BIRMINGHAM UNIV. RECOMMENDATIONS FOR INSPECTION WORKING CONDITIONS.

Estimated Saving - Not yet evaluated.

Actual Saving - Not yet implemented.

2.3.12. DESIGN AN INCENTIVE SCHEME FOR INSPECTORS.

- Evaluation being conducted by Industrial Engineers.

3. TECHNIQUES INTRODUCED AS PART OF I.H.D. WORK.

- Project Approach.

- Project Evaluation
    - Cost Model.
    - Accounting Data.

- Project Programme/Planning.

- Post Project Evaluation.

- Gross Financial Evaluation.

4. I.H.D. WORK AND IT'S APPLICATIONS 73/74.

- WHAT · should be done?

- BY WHOM e.g. J.R.B., PROJECT TEAM?

- WHERE, should work be kept within Lockheed Dept.

- WHEN should my work be finishing?

APPENDIX G

MANUAL

AN APPROACH TO PROFIT IMPROVEMENT

- THE TECHNIQUES INVOLVED.

CONTENTS

1. THE AIM OF THE PROFIT IMPROVEMENT OPPORTUNITY APPROACH.

The approach described in this manual can be introduced in terms of its three main aims.

1. To produce an accurate evaluation of profit improvement ideas/projects.

2. To manage the conduct of projects effectively.

3. To analyse/check the effectiveness of the projects.

The primary aim of the approach is to produce an accurate evaluation of any potential idea for improving profitability. This should mean that management decisions, on whether or not to use any particular idea, can be made with a good degree of confidence in the end result.

If this evaluation is to be financially accurate, then it must be performed in such a way as to account for <u>all</u> arguments for and against the idea. Provided these arguments are set out clearly, the manager deciding whether to implement a proposal sees all its aspects and implications. Hopefully therefore, one can by this approach anticipate all the more subjective arguments/prejudices, and can show that they have been considered in the evaluation, thus pre-empting decisions based largely on unquantified opinions.

By evaluating all profit improvement ideas in this fashion, and relating these evaluations to one another, it is also possible to eliminate the occurrence of what may be termed double counting of savings.

Double counting of savings can occur when two different "service" departments are both working on the same 'area', unaware of each others aims. In an extreme case we might have the Industrial Engineering Dept. reducing a machine cycle by a method change, whilst the Production Engineering Dept. may be reducing the same cycle time by modification of the machinery or the Technical Dept. by developing better materials specifications.

Unless account is taken of the effect of each idea on the area, before evaluating the next idea, then double counting will occur.

E.g., If idea No. 1 produces a labour saving of 20% in area A(work force 10 men), then the saving = 2 men.

Now if idea No. 2 is also effective in area A, and results in a 50% labour saving, then the labour saving is 50% of 8 men = 4 men

NOT 50% of 10 men = 5 men.

So the total savings in area A from Ideas 1 + 2 are:

2 + 4 = 6 men NOT 2 + 5 = 7 men

i.e., All savings are not directly additive until double counting has been eliminated.

Thus if we are to effectively combat double counting of savings, which would lead to misallocation of research, resources and expenditure, ALL ideas must be evaluated and examined for double counting affects. Each evaluation should predict an end state, which can be used as a starting point in evaluating other opportunities. However, the improved co-ordination that follows can also bring about more obvious benefits by improvements in the allocation of resources. The time spent by one department may be totally wasted because changes introduced by another rendered their analysis inapplicable. We could of course also find that two departments were covering similar ground, and wasting resources by duplicating work. These two situations do not arise if the suggested procedures are followed exactly.

In fact the first phase of the approach can be called a feasibility study, since we are basically examining ideas to see whether implementation is feasible. This leads us to the second aim of the overall approach, which is to manage the conduct of projects effectively, until implementation of successful ideas has been achieved.

Following evaluation, all profitable ideas for a particular area/department are submitted for management approval. Then on acceptance, the ideas are formed into a project programme. The purpose of the programme is to inform the 'area'/department manager of the progress of individual projects, and how his resources are being used. Also from the programme the overall effect of the approved work on the area/department can be predicted.

In drawing up the programme it will be necessary to categorise projects, depending on the expected results of the project.

e.g., not all projects will be expected to produce savings, so what is their purpose?

After the primary evaluation projects fall into 3 main classes:

(1) Feasibility

(2) Research

(3) Implementation

and in the above order they can also be considered the development stages of a project. To expand on this last statement, if primary evaluation indicateds a saving, we must then decide whether its practical to implement the idea, or whether further research is required to develop alternative solutions, or to evaluate savings in more detail. In some cases the decision to implement can be made without further information. However, cases will occur when further research must be done, or when the implications of implementation must be more clearly defined.

So at the stage of programme production we can be faced with three types of projects:

(1) Feasibility study - to produce a decision as to whether further research is required, or implementation can take place on present evidence.

(2) Research - to produce results to clarify estimated savings.

(3) Implementation - to produce estimated savings.

The final aim of the approach is to check that the estimated savings have been obtained, and where necessary the reasons for failure found, and noted for future reference. This part of the approach should prove useful in evaluating savings on capital expenditure for 'half yearly' reports; as well as giving a check on the accuracy of the estimates of savings.

2. STAGES IN THE APPROACH.

The approach can be sub divided into 12 stages. These are:

1. Produce a Cost Model of the Department.
2. Collect and/or generate ideas affecting the Department.
3. List the Pros. and Cons. for each Idea.
4. List the facts required to evaluate each Pro. and Con.
5. Produce the information to evaluate the Pros. and Cons.
6. Evaluate the Pros. and Cons. on a financial basis, and calculate the net effect of each idea.
7. Examine ideas for "double counting".
8. Present the ideas for management decisions on implementation.
9. Categorise all acceptable ideas.
10. Produce a programme for all the ideas.
11. Monitor the progress of each project.
12. Evaluate the savings or results produced on completion of each project.

One can of course at any time initiate a new wave of ideas, and integrate their evaluation with the on-going programme, via a repetition of phase 9.

2.1. PRODUCE A COST MODEL OF THE DEPARTMENT.

It is important, in the use of approach, that the person responsible for evaluation of ideas is familiar with the cost areas in the department, the inter-dependence of these areas, and the magnitude scales of the costs involved. For these reasons the first step in the approach is to produce a cost model of the area. Sometimes the accounts for a department may prove adequate, but accounts are rarely prepared with our purposes in mind, and they may not reflect the technology adequately.

Building a model improves the evaluator's understanding of the cost structure of the department, and his ability to predict the effect that any action on a particular area, will have on the department as a whole. To take an example, the reduction of waste at an early stage of the production process, may well have effects at subsequent stages. These effects can be evaluated from an adequate cost model.

There are numerous types of models covering many areas, which might be of use e.g., large scale financial models of:

The department

The factory/company

The customer/market

or more detailed departmental models of:

labour

materials

wastage.

Depending on the type of operating environment of the department more than one model may be required. Also the type of models required will be dictated to a certain extent by the information required to evaluate the Pros. and Cons.

As said previously the models produced must be such that the effects of actions in one sector will, where required, have known, or calculable effects in other related areas.

Instruction of the formation of cost models will be given in section 3.

2.2. COLLECT AND/OR GENERATE ALL IDEAS AFFECTING THE DEPARTMENT.

The first part of this stage is to gather together all ideas/projects, which are concerned with the department. This will inevitably mean consulting the "service departments" e.g., Industrial Engineering, Technical, Engineering, Personnel etc., for information on intended projects, and possible ideas not yet evaluated.

Then further ideas can be generated in a number of ways. These include "brainstorming sessions", suggestions schemes, or even talking to people about their particular problems and the possible solutions.

There are two important reasons for ensuring that all ideas/projects have been covered. The first is so that the manager responsible for the department, and who is likely to be involved in drawing up the project programme, is fully aware of how and where his resources are being used, and to what end. The second reason is to combat double counting of savings, as illustrated in the aim of the approach. Thus in extreme cases of double counting, the effect of a second idea might be negligible after implementation of the first or vice-versa. In such cases a decision must be made on which idea to implement, or even which to study first, and such decisions may have political implications.

2.3. LIST THE PROS. AND CONS. FOR EACH IDEA.

This stage simply involves listing all the arguments for (Pros.) and all argument against (Cons.) any given idea.

The majority of these arguments can be listed by the person evaluating the idea. However, whenever possible, the idea should be put to a known opponent, and his/her arguments against recorded. In this way one can begin an evaluation with all the reasons for rejection before one. Then, hopefully, when the evaluation is completed, it will stand on its financial merit, not to be vetoed for any unanticipated and therefore unquantified and possibly subjective reason.

Listing the arguments does also show the reader of the evaluation the ground that has been covered, and that all the arguments have been considered logically. Also the reader can check quickly whether specific points have been covered, without having to read the whole evaluation.

2.4 LIST THE FACTS REQUIRED TO EVALUATE EACH PRO. AND CON.

One might feel that stages 2.3 and 2.4 should be combined, or even 2.3 2.4 and 2.5, however, if one is to produce a sound evaluation it is worth spending the time to produce a detailed logical presentation, which not only helps the reader, but also the person doing the evaluation.

It is advisable to prepare this section in a reasonable amount of detail, since this tends to aid the collection of information. In other words the more specific the required information is, the easier it should be to trace, especially if the initial stages of tracing has to be done by word of mouth.

2.5. PRODUCE THE INFORMATION REQUIRED TO EVALUATE THE PROS. AND CONS.

Provided that the previous stage (2.4) has been performed with sufficient care and attention, then this stage should be relatively straight forward. Whether or not this is the case will depend on the availability of information, and the form in which it is presented.

At this stage the cost model will often be required to predict the effects in related areas, following the introduction of a particular idea in a certain area.

If the information is completely unobtainable from departmental/company records, then an estimate must be obtained from a "reliable" person, with a sound knowledge of the area in question. Every attempt must be made to ensure that information is produced. When such an estimate is obtained, it is important to note the likely accuracy, and the importance of the figure when used in producing the net financial effect of the idea.

e.g., Should the estimate account for a large portion of the savings from an idea, then before implementation further research may be required to confirm the accuracy of the savings.

2.6. EVALUATE THE PROS. AND CONS. ON A FINANCIAL BASIS, AND CALCULATE THE NET FINANCIAL EFFECT OF EACH IDEA.

From the information collected during stage 5 of the approach, it should be possible to assign a financial value to each Pro. and Con. argument, for every idea.

Having done this, the total value for all arguments for and against, for any one idea, are found by summing all the financial values of the Pros. and Cons. The net effect of the idea is then found by subtracting the Cons. total from the Pros. total. Should the net effect produce a positive result then this represents a saving.

When the net effect is negative, implementation would result in a loss.

27. EXAMINE IDEAS FOR DOUBLE COUNTING OF SAVINGS.

As was stated in the introduction, savings from all ideas are not directly additive until double counting has been eliminated. So it is vitally important that before any decisions on implementation are taken, all double counting must be discovered. It can then be eliminated, at this stage, by reducing the value of savings of certain ideas, or at the next stage by management decisions not to implement certain projects which involve double counting. This latter case will be applicable if two ideas are opposed, or when the effect of the second becomes negligible after implementation of the first.

One method of discovering double counting is to divide the department into its more easily identifiable production cost areas. Then, using these specific headings, list all the ideas that have an effect on that particular area, and their net estimated savings in that area.

Having done this, it should then be apparent when double counting is occurring, and to what extent it is likely to affect savings.

2.8. PRESENT THE IDEAS FOR MANAGEMENT DECISIONS ON IMPLEMENTATION

By the time we reach this stage in the approach we should have produced an accurately evaluated, list of ideas, which can be presented to higher management for decisions on implementation. This list will indicate the profit or loss expected from implementation of an idea, and will also account for interaction of ideas.

Thus, in theory, the decision on implementation should depend on the degree of financial savings expected, and the availability of resources for implementation work. In certain cases ideas may be over-ruled for unforeseen reasons of a "political" nature.

e.g., Increased liability for quality and performance to the customer.

In some cases these arguments could have been produced at the beginning of evaluation, thus saving considerable time and energy. The argument against this type of early veto is that in a small number of cases the estimated savings may be sufficient to bring about a change in the political climate!

.2.9. CATEGORISE ALL ACCEPTABLE IDEAS.

As was mentioned in the introductory section, not all ideas are suitable for implementation immediately after a Pros. v. Cons. evaluation. For this reason not all work on ideas will result in savings, and when producing a project programme we must bear this in mind, especially when allocating resources.

The three classes of idea which may appear on the programme are as follows:

(1) Feasibility studies - as was stated in the introduction, this study is the first phase in the development of a project. Therefore, those ideas most recently produced, and not yet evaluated fall into this class.

(2) Research Ideas - are those which require more detailed information on savings before a decision on implementation can be taken.

(3) Implementation Ideas - these are ideas with accurately predicted effects, selected for immediate action, producing known savings.

Hence from the three classes of idea, we would only expect financial savings from the last, at this stage. However, the information gained from the other two types could eventually lead to an implementation idea, and therefore, savings.

2.10.

PRODUCE A PROGRAMME FOR ALL THE IDEAS.

We now have a list of ideas for implementation, and the next step is to form them into a sensible order or work programme. Before this order/programme can be produced a number of facts must be established. These are:

(1) Interdependence of projects, i.e., whether certain projects have to be completed, before others can begin.

(2) The main area/s of work for each project.

(3) The availability of departmental resources to perform project work.

Once this information has been obtained the evaluator and the manager responsible for the programme (e.g., dept. manager) can draw up the programme.

The first step to assign to each project, a project leader from the main area of work of the project, e.g., a process controller would take charge of a production engineering project. Then the projects can be arranged in order of importance to the department, bearing in mind any interdependence of projects.

e.g., Those implementation ideas with the largest savings are likely to have the highest priority, as might those research ideas that might lead to large savings.

At this stage a list of projects can be produced showing:

(1) Project title.

(2) Main area of work.

(3) Project leader.

2.10.
(continued)

The evaluator and/or the programme manager must then discuss the implcations, i.e., savings/work involved, of each project with the respective project leader. Having done this, the project leader must then estimate how long a particular project will take. These times are then vetted by the programme manager, and altered after discussion with project leaders where necessary.

The final stage of programme production is to add to the previous list showing project, main area of work, and leader, the completion date of each project. These dates will be based on the target times set by project leaders, taking account of any conflicts in the allocation of resources.

This programme must then be circulated to all involved in the programme.

2.11. MONITOR THE PROGRESS OF EACH PROJECT

There are two reasons for wanting to monitor the progress of individual projects. The first is the fairly obvious reason of keeping the manager responsible for the programme informed on the progress and/or problems of individual projects. The second is to help maintain the interest and momentum of the project leaders in their work, by reminding them of their targets.

Monitoring is done by means of a simple Gantt activity chart, which shows the target date for completion, the estimated length, and the % completion at that time of individual project. This chart is up dated weekly by a 'programme monitor', who finds from the project leaders the % completion of individual projects that week. The chart can then be produced to show whether individual projects, are, on, behind or ahead of schedule. This information would be important if the programme manager has to re-allocate some of his resources.

Production of a Gantt activity chart is explained in section 3.

2.12.

EVALUATE THE SAVINGS OR RESULTS, PRODUCED ON COMPLETION OF EACH PROJECT

The final stage of the approach should be, to the evaluator one of the most important stages. Since at this stage he/she has to measure how accurate the predictions that were made have been. On his/her evaluation of the savings achieved management will judge the overall success of the work done.

To evaluate the savings, we have to return to the predictions made during the Pros. v Cons. evaluation. Then results have to be produced that show the changes arising from implementation of the ideas, and also the extent to which the estimated savings/changes, agree with the actual savings/changes.

It may not be sufficient just to check that savings have been made. It may be necessary to produce a report for management detailing actual savings, and comparing them with predicted savings.

3. TECHNIQUES INVOLVED AT VARIOUS STAGES

This section contains details of four techniques used, which may unfamiliar to the reader, and examples of the use of each.

The four are:

1. Model Building.
2. Evaluation of Profit Improvement Opportunities.
3. Elimination of double counting of savings.
4. Construction of a Gantt Activity Chart and its use.

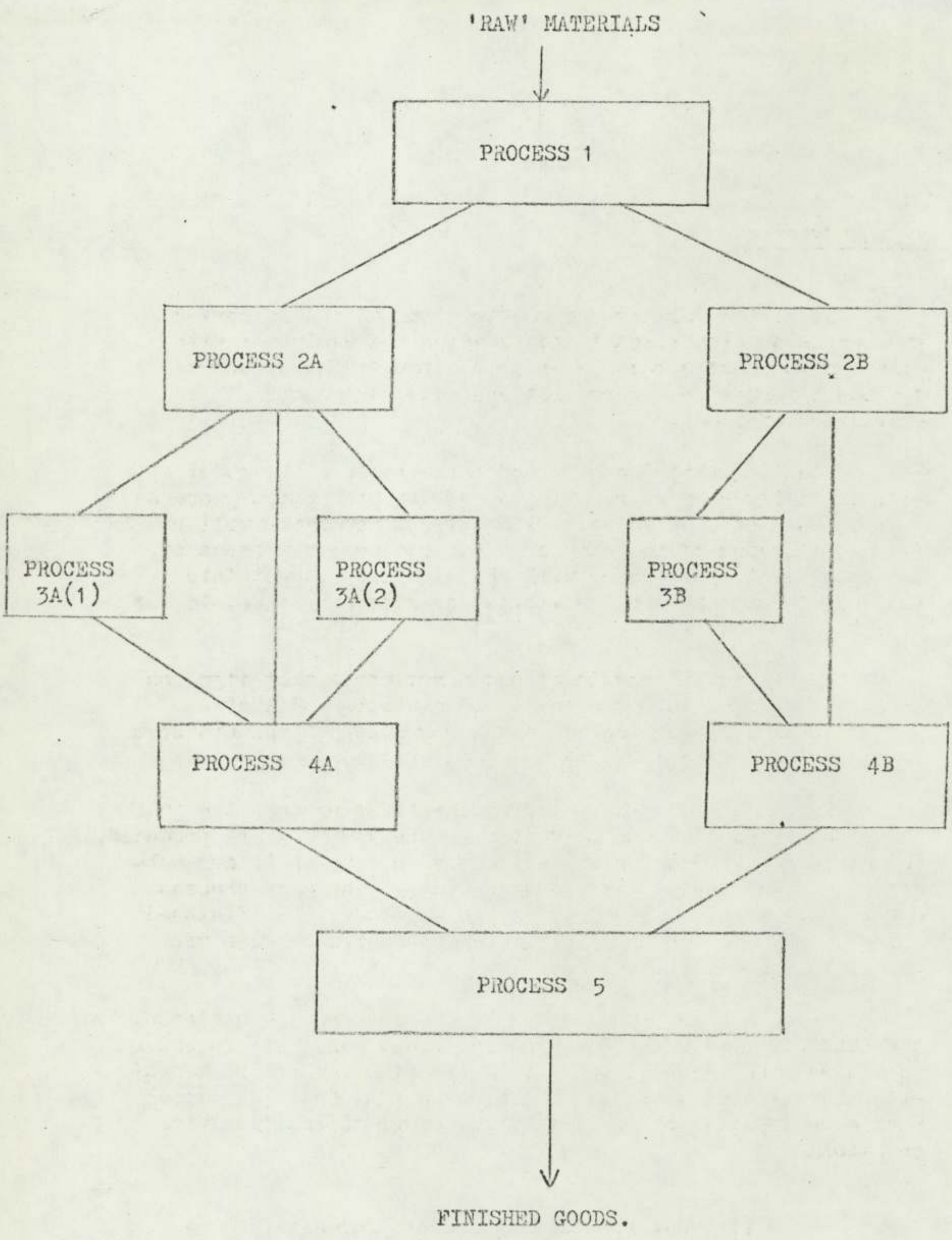


FIG.1.

(OUTLINE OF THE PRODUCTION PROCESS).

3.1.

MODEL BUILDING

As stated earlier the construction of models serves two purposes. The first is to acquaint the evaluator with workings and cost structure of a department; the second to provide information for predictions made during the evaluation of ideas.

Starting with the first of these reasons the model will initially be a representation of the production process of the deparment. Hence the first step in building will be an understanding of the stages in the production process of the department. Beginning with the materials bought into the department, through the various production stages, to the finished product.

Fig.1. is an example of the first model that might be constructed for a department. It is a simple model of a production area producing two similar groups of products from the same 'raw' materials, by different processes.

In the example shown, after the first process the two groups of products A and B, differ in the way they are produced, for different production stages, and even form their own sub-groups. Then finally all products undergo the same process e.g., inspection, before leaving the department as 'finished goods'. Thus we can now see the relationships between the various stages of production.

Once we have produced our Production process skeleton, the next step is to put the "costing flesh" onto it; in order to achieve the second aim i.e., information for prediction of effects following action in the model/department. The model should be capable of supplying the answer to the following questions:

1) What are the major costs for each stage in the production process?

2) What effect will actions in any area have on the related areas?

3.1.
(Continued)

To discover which the most important costs are, we have to examine the accounts. In fact it may be sufficient to break down the costs into four major areas:

1. Materials

2. Labour.

3. Other Variables Costs (e.g. Maintenance,Power)

4. Fixed Costs,

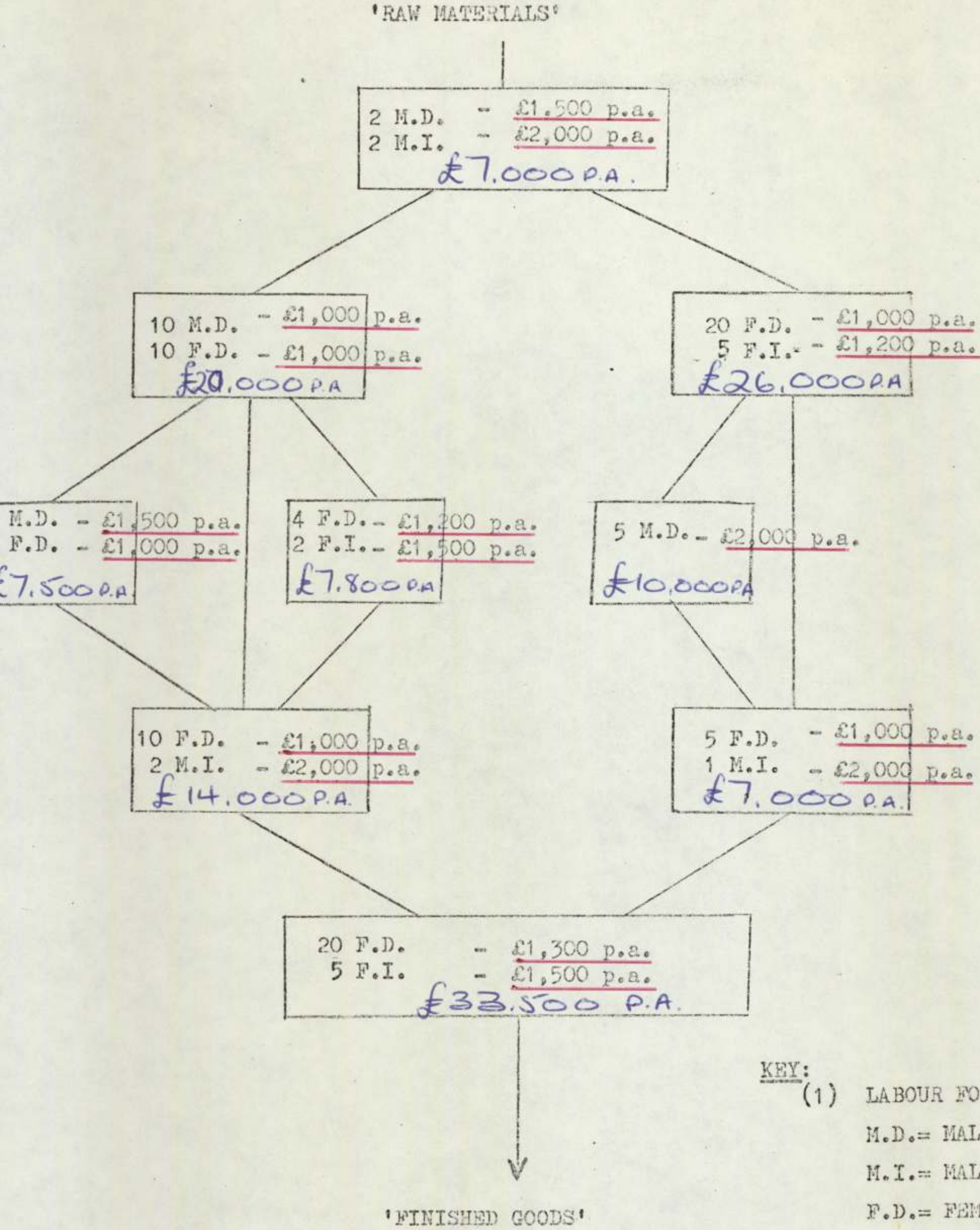
which may show us the most important cost area/s.

E.g., if the breakdown of the departmental costs where as follows:

1.	Materials	15%
2.	Labour	50%
3.	Other Variable	10%
4.	Fixed	25%

the first model we would build is the labour cost model. Since the labour cost is the greatest contributor to departmental costs, and if savings of a similar magnituded were to be attempted in any of the four areas, those in the labour area would have the greatest effect on total costs.

Then using our "process skeleton" (fig.1.), we have to evaluate the labour costs at each stage of production. The ease with which this is achieved will depend on the availability of information.



KEY:
(1) LABOUR FORCE
M.D.= MALE DIRECT
M.I.= MALE INDIRECT
F.D.= FEMALE DIRECT
F.I.=FEMALE INDIRECT
(2) AV.EARNINGS
(3) SECTION TOTAL ———

FIG. 2.

LABOUR COST MODEL

e.g.; It may be, that some cost centre figures are available, giving the labour costs for each stage of production as identified in the first model. However, it is more likely that the costs will have to be built up from more basic information, in the following manner:

1. Determine for each stage the labour force i.e., Direct and Indirect Labour, Male or Female.

2. Determine the average earnings for the class of labour in each area.

3. Then calculate the total earnings of the labour force in each area.

See fig.(2) for the above steps:

Step 1	-	BLACK FIG	-	LABOUR FORCE.
2	-	RED FIG	-	AVE.EARNINGS OF OPERATORS
3	-	BLUE FIG	-	TOTAL LABOUR COSTS IN THAT SECTION

However, in this state (i.e., fig.2) the model is still very simple, and the use we make of it from now on will depend to a great extent on the facts we need to know for evaluation of ideas.

e.g., (to develop our model even further).

If, in the department in question, the scrap or wastage is high, then we might need to know the cost of labour that is wasted in producing these non saleable parts. The model will now become more complex, in so far as it will contain more information.

PROCESS 'B'

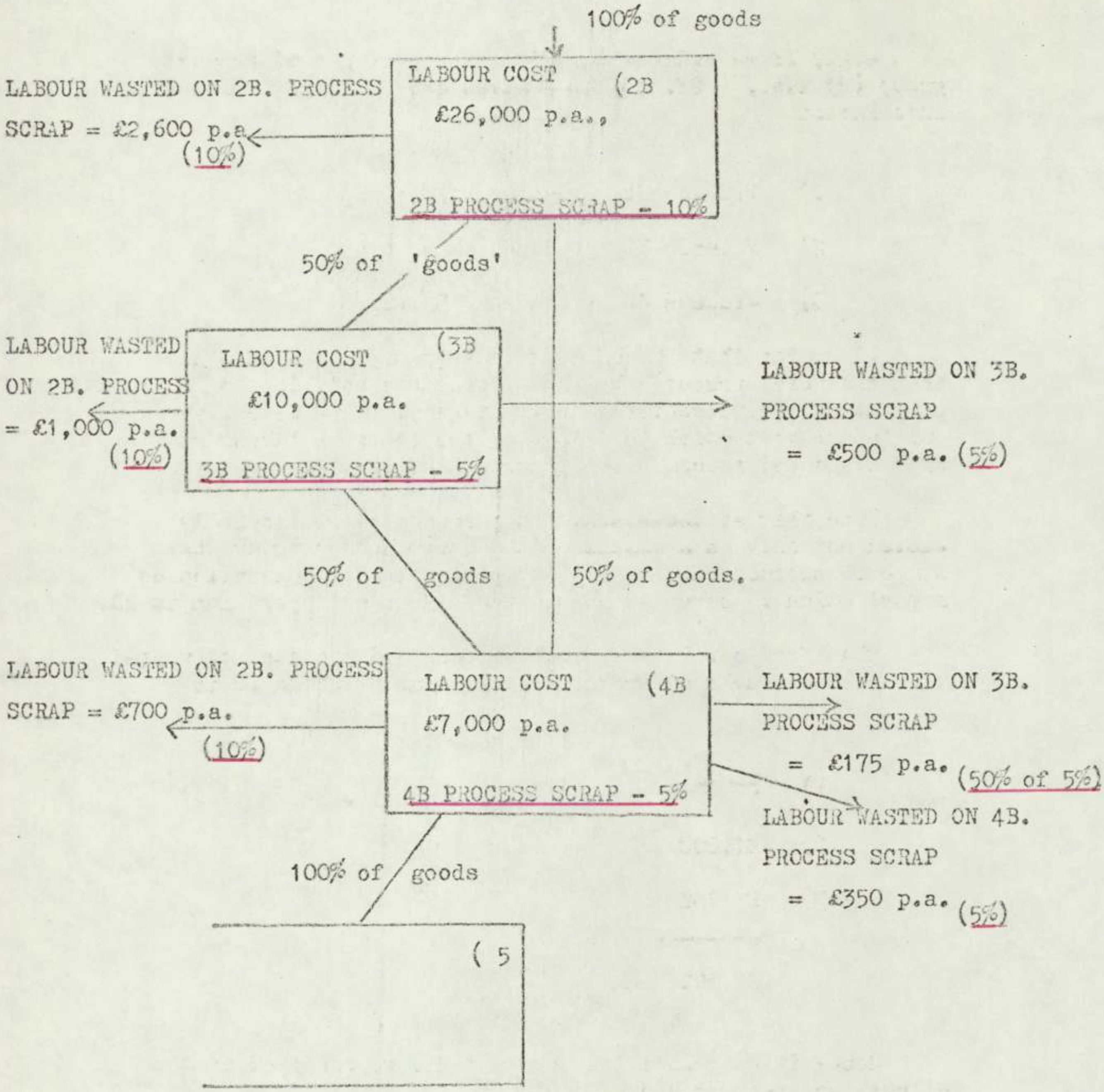


FIG.3.

LABOUR SCRAP MODEL FOR PROCESS B.

e.g.; If we examine the first three stages of product group (B) i.e., (2B. 3B. 4B) given the following scrap information:

1) Process 2B produces 10% scrap

2) Process 3B produces 5% scrap

3) Process 4B produces 5% scrap.

(Assuming that 50% of work undergoes process 3B), and that the scrap produced by the processes is not, in the present system, discovered until stage 5. Then we can use our labour cost model to calculate the costs of labour at each stage in producing scrap parts (see fig.3).

Note that at those stages subsequent to 2B labour is wasted not only as a result of the scrap occurring at that stage of production, but also by performing the operation on a part which is scrap as a result of imperfect operation at 2B.

Thus from our latest model we can find the cost of wasted labour as a result of producing 10% scrap at stage 2B is:

1) £2,600

2) £1,000

3) £ 700

£4,300 p.a.

Hence if we reduce the scrap at 2B, we can predict the effects on areas 3B and 4B.

3.2.

EVALUATION OF PROFIT IMPROVEMENT IDEAS.

The following is simply the process of evaluation (stages 2 to 6 in the approach) followed in one example.

STAGE 2

Idea - Introduce a shift takeover system on the Injection Moulding area.

STAGE 3

Arguments

Pro.

1. Save material wasted during the present shutdown/ start up procedure.
2. Increase the output capacity, by continuous working of the machines, hence increasing the sales turnover.

Con.

1. Increase the labour costs of Injection Moulding area by paying shift takeover allowance.
2. Increase maintenance costs for the area by running machines longer.
3. Increase the power consumption hence costs for the area by continually running the machines.

3.2.

(Continued)

STAGE 4 FACTS REQUIRED. Pros.	STAGE 5 PRODUCTION OF INFO.
1.1. Wt of D.R.5. (VIRGIN RUBBER) used per machine in a shutdown/start up process.	150 grms.
1.2. Cost of D.R.5.	£0.2577 per kgrm.
1.3. Wt. of moulding compound wasted per machine in a shutdown/start up process.	1,020 grms.
1.4. Average cost of moulding compound	£0.1993 per kgrm.
1.5. No. of injection moulding machines	21
1.6. No. of shutdowns per machine per day	3
1.7. No. of working days p.a.	240 p.a.
2.1. Operator time wasted each time he shuts down a machine.	6 mins.
2.2. Operator time wasted starting up a machine.	6 mins.
2.3. Operator time wasted in "washing hands"!	5 mins.
2.4. Total No. of operators "wasting time" per shift	8
2.5. Total number of shift p.a.	3 x (240 / 5 x 48)
2.6. Present potential output in hours of operator working time per annum.	926 x 48 hrs. p.a.

3.2.
(Continued)

STAGE 4 (cont)	STAGE 5 (cont)
FACTS REQUIRED:	PRODUCTION OF INFO.
Cons.	
1.1. Takeover allowance per operator per shift.	20p.
1.2. Total number of shifts worker per operator p.a.	5 x 48 p.a. = 240
1.3. Total number of operators eligible for a takeover allowance.	27
2.1. Present cost of maintenance for the injection moulding area. 2.2. Estimated cost of maintenance area after increased use of machines.	Information from model or accounts if necessary, in this case increase is likely to be negligible.
3.1. Present costs of power to operate the injection section. 3.2. Estimated power costs after implementation of takeover system.	Again info from a model or accounts, in this case power is used by machines even when temporarily shut down therefore, there will be no increase in costs.

STAGE 6

EVALUATION OF 'PROS' AND 'CONS'

PROS.

(1) Saving in wasted material.

$$= \left(\frac{1.1 \times 1.2}{1000} + \frac{1.3 \times 1.4}{1000}\right)(1.5 \times 1.6 \times 1.7)$$

$$= \left(\frac{150 \times £0.2577}{1000} + \frac{1{,}020 \times £0.1993}{1000}\right)(\times 21 \times 3 \times 48)$$

(D.R.5.) (MOULDING COMPOUND)

$$= £\,(0.15 \times 0.2577 + 1.02 \times 0.1993) \times 15{,}120$$

$$= £3{,}650 \text{ p.a.}$$

(2) Increase in output capacity = Extra time available = Time previously 'wasted'

$$= (2.1 + 2.2. + 2.3) \times 2.4 \times 2.5$$

$$= (6 + 6 + 5) \times 8 \times 3 \times 5 \times 48 \text{ mins. p.a.,}$$

$$= 17 \times \frac{8 \times 3 \times 5 \times 48}{60} \text{ hrs. p.a.,}$$

$$= 17 \times 8 \times 12 \text{ hrs. p.a.,}$$

$\therefore$ % increase in output capacity $= \frac{\text{Extra time}}{\text{Present capacity}} \times 100$

$$= \frac{17 \times 8 \times 12}{926 \times 48} \times 100 = \frac{34}{926} \times 100 \doteqdot 3.7\%$$

STAGE 6 (continued)

NOTE: in the case of Pro. No. 2 we have not claimed a saving because although we have increased our output potential the extra output may not be required, e.g., if we are unable to sell the extra. However, if we are to claim an increase in sales [illegible], for only a small increase in injection moulding costs, we must add to our cons arguments the fact that 3.7% more labour will be required at subsequent stages of production.

Hence our total savings from the Pros. arguments

= 1 + 2 (=0)

= £3,650 p.a.

CONS.

1. The total cost of implementing a takeover system.

= 1.1 x 1.2 x 1.3

= 20p. x 5 x 48 x 27 p.a.

= £1,326 p.a.,

2. Increase in maintenance costs = 2.2 - 2.1 = 0

3. Increase in power costs = 3.2 - 3.1 = 0

∴ Total Cost of the Idea 1 + 2 + 3 = £1,326 p.a.,

∴ The Net Saving from the idea

= £3,650 - £1,326 p.a.

= £2,324 p.a.

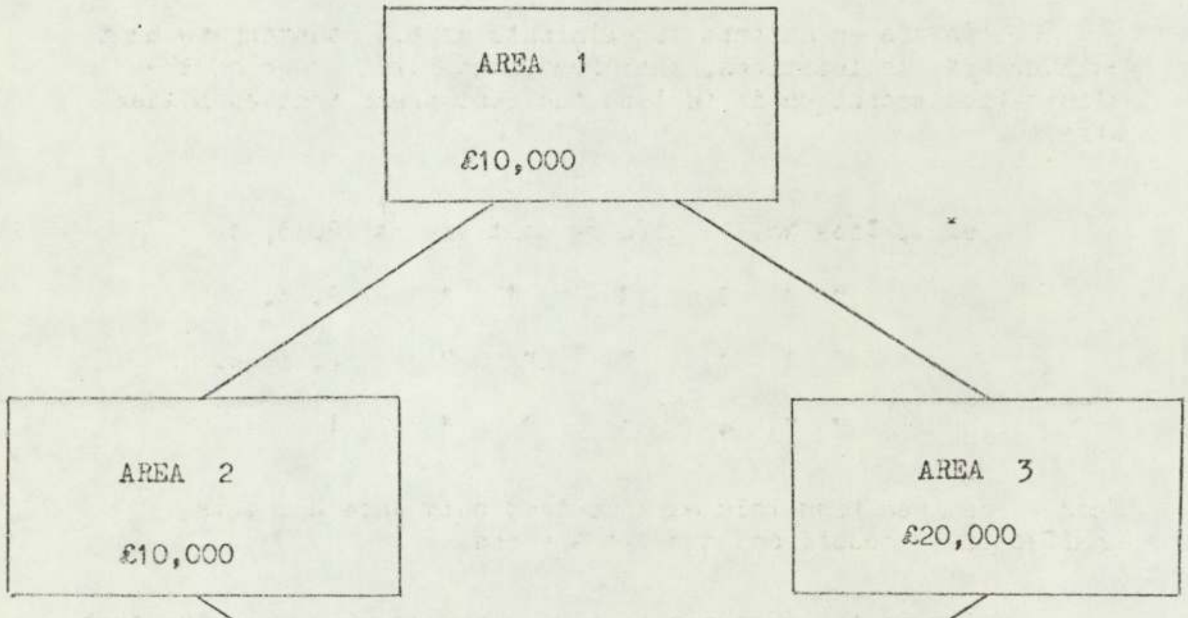


FIG.4.

3.3.

ELIMINATION OF DOUBLE COUNTING OF SAVINGS

Before we attempt to eliminate double counting we must be aware of its locations, therefore, the first stage of the elimination technique is to list the cost areas that each idea affects.

e.g., Idea No. 1	affects cost area/s	2, 3, 4.
" " 2	" " "	2, 4.
" " 3	" " "	2, 3, 4.
" " 4	" " "	1

Thus we can see from this example that only Idea No. 4 is unaffected by double counting of savings.

Now if the cost areas in the example above are the cost areas shown in the fig. opposite we can eliminate double counting for ideas 1, 2 and 3.

Assuming for simplicity that each idea reduces the costs in each area it affects by 10% then the initial evaluation of savings would be as follows.

No. 1 10% of £10,000 + 10% of £20,000 + 10% of £20,000

= £1,000 + £2,000 + £2,000 = £5,000 p.a.

No. 2 10% of £10,000 + 10% of £20,000

= £3,000 p.a.

No. 3 10% of £10,000 + 10% of £20,000 + 10% of £20,000

= £5,000 p.a.

i.e., a total of £13,000 p.a.

3.3.

(continued)

<u>But</u> because Idea No. 1 reduces the costs in areas 2, 3 and 4 by 10%, Idea No. 2 now saves 10% of costs which have been reduced by Idea 1.

i.e., 10% of £9,000 (Area 2) + 10% of £18,000 (Area 4)

= £900 + £1,800 p.a.

= £2,700 p.a. cf £3,000 p.a. originally,

and savings from Idea No. 3 are now acting on costs reduced by ideas 1 + 2.

i.e., 10% of £8,100 (Area 2)

+ 10% of £18,000 (Area 3)

+ 10% of £16,200 (Area 4)

= £810 + £1,800 + £1,620

= £4,230 p.a., cf £5,000 p.a. originally.

∴ total for the three ideas is now £11,930 p.a. against an original figure of £13,000 p.a., i.e., total savings have been reduced by £1,070 p.a.

3.4.

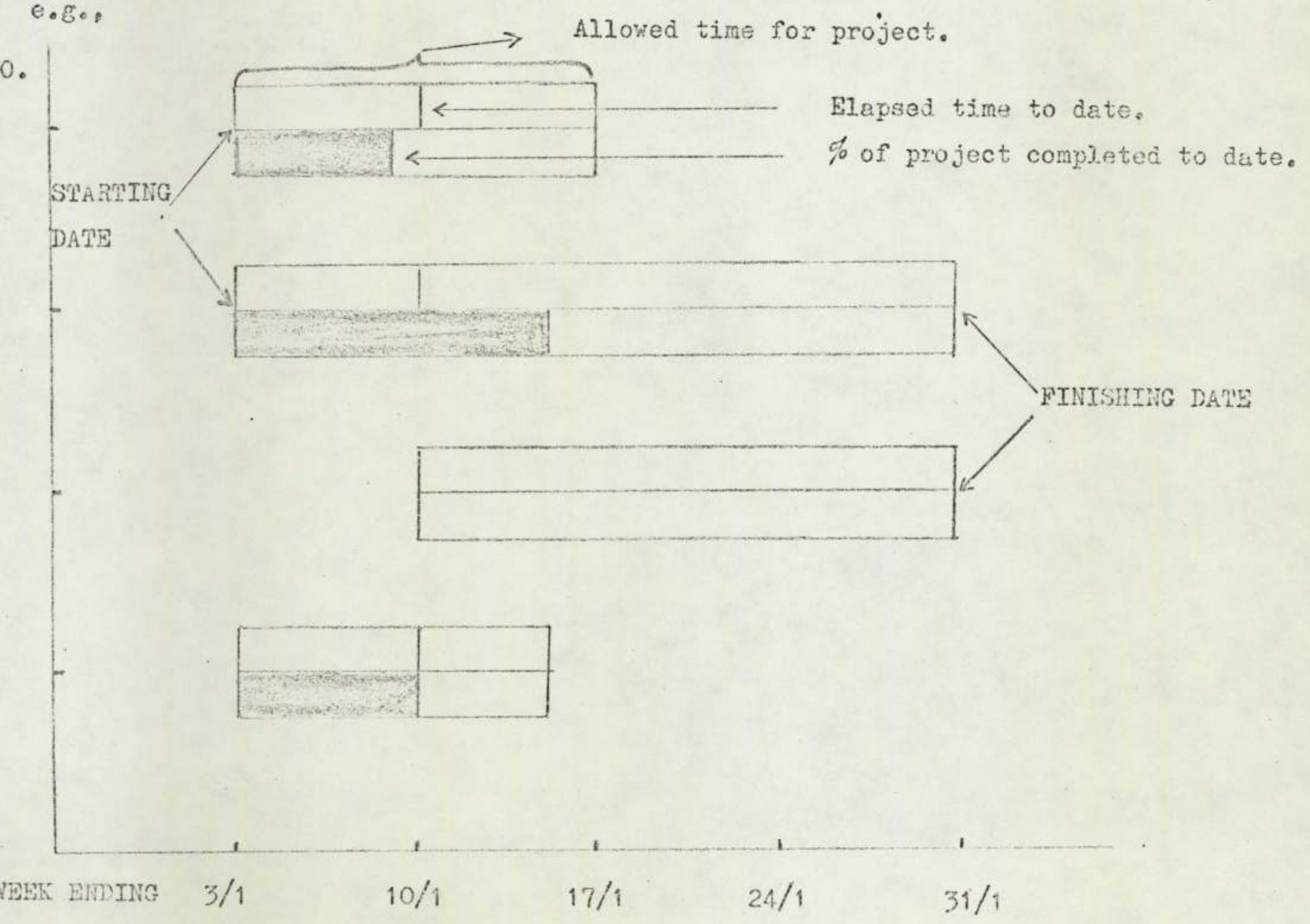
THE GANTT ACTIVITY CHART

This chart is basically a simple bar chart, which is up-dated by increasing the lengths of the bars each week progress is achieved. The chart should show the following, (based on the project programme).

1. The starting date for each project.
2. The length of time set for each project.
3. The target date for completion.
4. The percentage of work done to date.
5. The percentage of the set time which has elapsed to date.

Hence the chart will show whether or not projects are on schedule.

e.g.,



3.4.
(continued)

Information gained from the example of the chart shown:

Idea No. 1 behind schedule.

Idea No. 2 ahead of schedule.

Idea No. 3 not yet started.

Idea No. 4 on schedule.

APPENDIX H

MANUAL

GROSS RETROSPECTIVE ANALYSIS

G R A F F I T I

GROSS RETROSPECTIVE ANALYSIS (for financial investigators to implement).

J. R. BAINBRIDGE

1974

CONTENTS

INTRODUCTION

To quote a Group Industrial Engineering manual, "The Dunlop approach to management and control emanates from the Management Plan, in which are set out the financial targets that have to be achieved." However, although much time is spent preparing for the future, little time is taken to examine the past.

The accounts do not indicate, in most forms of presentation, how effective management and control have been. Indeed overall financial targets could have been achieved by good fortune rather than good management. Examples occur of effects cancelling each other out, e.g., an increase in wages rates offset by a reduction in labour, leaving the wages bill unchanged.

The purpose of a Gross Retrospective Analysis (G.R.A.) exercise is to determine quantitatively the reasons for change, or absence of change, in profitability during a particular period.

There are of course many changes that can occur within a department that may not, in the final presentation of accounts, be apparent from the balance sheet.

In fact by G.R.A. it should be possible to progress from the financial state of the department at the beginning of the period under review, via the financial effects of actions taken or imposed on the department during the period, to the financial situation at the end. Certainly in the majority of cases the financial effects of particular actions will not be apparent from the accounts.

Hence good or bad management actions can be overlooked or hidden by presenting a general (gross?) financial picture of before and after, with little or no consideration for the transition stages. Rather like a body building advert showing "Mr. Muscle" before and after the course, making no mention of a two year interim period in which "Mr. Muscle" was off work for a total of 15 months with dislocated elbow and knee joints, caused by using the magnificent body building machine!

These "dislocations" as well as the reasons for his "improved physique" should become apparent after the G.R.A. of such a situation.

INTRODUCTION: (continued)

It is also possible that this type of analysis may indicate particular areas that, with improved management or control, could lead to significant improvements in profitability.

e.g. The discovery that a change in product mix had affected profit, might suggest that the mix be manipulated to maintain or improve the profit.

2. THE APPLICATION AND TECHNIQUES OF G.R.A.

The analysis can be broken down into threephases as follows:

1. Examination of the 'balance sheet' to determine the change in profit over the period to be considered.

2. Collection of information required to explain the change in profit.

3. Evaluation of the financial effects of individual actions in the department.

The approach aims to isolate the individual reasons for change in profitability, and then show that the sum total of all the changes is equal to the change in profit.

In fact, the compilation of all changes into a final 'balance sheet' helps to put into perspective the effect of individual changes. Also it serves as a check on the accuracy of the information provided.

The explanation of G.R.A. is accompanied by a worked example of its application, on a set of figures produced for the purpose of this example.

Balance Sheet.

PERIOD	1	2
SALES REVENUE	£105,000	£142,000
TOTAL COSTS	£100,000	£109,960
PROFIT	£ 5,000	£ 32,040

fig. 1.

2.1. EXAMINATION OF THE BALANCE SHEET

The purpose of the first phase is to establish the change, or in some cases the lack of change, in the profit of the department under review during the assigned period of time.

The simple balance sheet in fig.1. opposite, shows that the profit has risen from £5,000 during period 1, to £32,0404 during period 2. i.e., an increase of £27,040.

In this case the rise can be attributed to an increase in total costs accompanied by a greater increase in sales revenue, producing a net increase in profit of £27,040. However, we must dig deeper if we are to discover whether the increased profit is a result of good management and control, or good fortune i.e., favourable actions beyond the control of management.

In fact we can have a series of situations in which profit may or may not change, which reveal nothing about the effectiveness of actions taken in the interim period, as can be seen from the table of changes below:

Profit	N/C	N/C	C	C	C
Sales Rev.	N/C	C	N/C	C	C
Total Costs	N/C	C	C	N/C	C

N/C - No change

C - Change

Even this table can be misleading since within the Sales and Cost figures there can have been many changes with zero net effect. It is these changes we aim to quantify by G.R.A.

2.2. 2.2. COLLECTION OF INFORMATION

As was seen in the last section we have two major areas for analysis:

1. Sales Revenue

2. Total Costs

If we examine these areas in detail we find that there are a number of factors, which can affect the overall figure for the area.

2.2.2.2.1 SALES REVENUE

This is the simpler of the two areas to analyse, since there are basically only three factors, which control the income from sales:

1. Prices of goods sold.

2. Quantities of goods sold.

3. Product mix.

Thus if we are to compare sales revenues over a period of time, then we must be aware of the effects of variations in any of these factors.

To analyse any causes of change in Sales Revenue we must have the following data for periods 1 and 2:

1. Quantities of each product sold.

2. Prices of individual products.

2.2.1 SALES REVENUE: (continued)

From this data it is possible to calculate the effects of variations in any one of the three factors. The method of analysis is explained in section 2.3.

2.2.2. TOTAL COSTS

Many factors can affect Total Costs besides Sales Revenue, so the first step is to obtain a break-down of total costs.

However, no analysis of these costs can be attempted until a comprehensive list of all actions taken in, or imposed on the department during the period under review has been obtained. This list can be sub-divided into the following main headings:

1. Implications of the changes in volume of goods manufactured, to be expressed in terms of changes in materials, labour, power, maintenance and other variable or semi variable costs, and also "fixed costs".

2. Implications of changes in mix of products being manufactured.

3. Labour figures ie., number of employees.

4. Enforced cost actions, e.g., increases in material and labour costs.

5. Cost reduction actions taken during the period.

6. Cost reductions of non too clearly defined origins e.g., fall in scrap costs, possibly due to improved operator morale.

7. Changes in Fixed Costs - likely to be beyond the control of management. Indeed in some cases figures for "fixed" costs for individual departments may not be available, e.g., if the accounts department does not allocate general factory fixed costs to individual departments.

SALES REVENUE FIGURES

PERIOD 1

Product		No. of units sold.	Price per unit(£)	Revenue(£)
A		100	250	25,000
B		200	100	20,000
C		100	200	20,000
D		400	50	20,000
E		200	100	20,000
	TOTAL	1,000 units		£105,000

PERIOD 2

A		100	250	25,000
B		300	110	33,000
C		150	200	30,000
D		300	80	24,000
E		250	120	30,000
	TOTAL	1,100 units		£142,000

fig.2.

2.3. EVALUATION OF THE FINANCIAL EFFECTS OF ACTIONS ON SALES REVENUE AND TOTAL COSTS.

2.31. SALES REVENUE

As we stated in the previous section we require two sets of information for each period, to analyse the reasons for change in sales revenue, they are:

1. Quantities of individual products sold.
2. Prices of individual products.

For the department we are considering the sales are shown in the table opposite fig.2. The first facts that are apparent from the table are:

1. Sales Revenue has risen by £37,040, a fact that we shall attempt to explain by G.R.A.
2. The total volume of parts sold has risen by 10%.
3. The average selling price per unit has risen by £24 from £105 $\left(\frac{£105,000}{1,000}\right)$ in period 1, to £129.1 $\left(\frac{£142,000}{1,100}\right)$ in period 2.

The problem is to separate the effects of changes in the three factors, mentioned in 2.21, which affect the income from sales. Of the several ways of doing this, we recommend the following.

The first reason for an increase in revenue is price increases. In this example we can assume that as a result of price negotiations, prices rose from those in period 1 to those shown in period 2. To analyse the effect of price increases, we simply calculate the sales revenue for the units sold in period 1, at the price charged during period 2. This calculation is shown in the table fig.3.

PRICE INCREASE EFFECT CALCULATION.

Product	No. of units sold in Pd.1	Price per unit Pd.2(£)	Revenue(£)
A	100	250	25,000
B	200	110	22,000
C	100	200	20,000
D	400	80	32,000
E	200	120	24,000
TOTAL :	1,000 units		£123,000

fig.3.

Product	No. of units sold in Pd.1	Price per unit Pd.2(£)	Revenue(£)
A	100	250	25,000
B	300	100	30,000
C	150	200	30,000
D	300	50	15,000
E	250	100	25,000
TOTAL :	1,100 units		£125,000

fig.4.

2.3.1. SALES REVENUE: (continued)

Then by comparing this figure for total revenue, with the actual revenue for period 1, i.e., £105,000 we can find the effect of price increases.

i.e. The increased prices resulted in an increase of sales revenue of £123,000 - £105,000 = £18,000

The second factor to consider is volume. In this example the total sales have risen by 100 units i.e. 10%. Now a straight increase of 10% in volume, on total sales of period 1, would result in an increase of £10,500 in sales revenue. i.e. The volume effect is simply the change in volume applied to the initial sales revenue.

Thus these two factors account for £28,500 out of a total change in sales revenue of £37,000; leaving a £8,500 increase, which we would expect to attribute to a change in product mix.

The product mix calculation can be performed in the following manner.

Firstly, calculate the sales revenue for the units sold during period 2 at the prices charged during period 1 i.e., the reverse of the calculation performed for evaluation of the effects of price increases. This calculation is shown in the table fig.4.

Secondly, calculate the sales revenue from period 1 volumes scaled up proportionally to the overall volume in period 2.

i.e., in this case $\text{Sales Rev. for period 1} \times \dfrac{\text{Tot.Vol.period 2}}{\text{Tot.Vol.period 1}}$

$$= £105,000 \times \frac{1,100}{1,100} = £115,500$$

Then the effect of change in product mix is the difference between the first and second calculated revenues.

i.e., The change in product mix resulted in an increase in revenue of £9,500.

TOTAL COST BREAKDOWN.

PERIOD	1 (£)	2 (£)
Materials	10,000	12,000
Labour	40,000	45,000
Maintenance	5,000	3,960
Power	3,000	3,000
Others	2,000	2,000
TOTAL VARIABLE COST	60,000	65,960
Fixed Costs	40,000	44,000
TOTAL COSTS	100,000	109,960

fig.5.

2.3.1. <u>SALES REVENUE</u>: (continued)

However, this is not the £8,500 increase we expected, and in fact from our calculations we would expect the following change in revenue:

From price changes	+	£18,000
From volume changes	+	£10,500
From mix changes	+	£ 9,500
giving a total increase of	+	£38,000 against
an actual increase of	+	£37,000

The reason for the difference between the actual and calculated increase in revenue, is that our calculations do not take into account the "interaction effect" between price changes and volume changes for individual products.

In fact in this case this "interaction effect" reduces the sales revenue by £1,000. Indeed if the calculations of effects of changes are performed as we have indicated, then the difference between the total calculated change and the actual change can be attributed to this effect.

A simple mathematical explanation of the reason for the occurrence of this effect can be found in Appendix A. This explanation also forms the basis of a single simple table, which when produced can be used to evaluate all the values of changes including the interaction effect.

2.3.2. <u>TOTAL COSTS</u>

The first piece of information we require for the total cost analysis is a simple breakdown of costs, as shown in fig.5. opposite. We have a net increase of £9,960 in the total costs of the department to account for. However, fixed costs are often beyond the control of departmental management. If that is the case here, we have an increase of £5,960 in variable costs to account for.

2.3.2. TOTAL COSTS: (continued)

The second set of information we require is a comprehensive list of all changes that have taken place in the department, which affect the variable costs. In this case they are shown below:

List of changes made or imposed on the department.

1. Increase in volume - 10%

2. Cost reduction actions:

   A Project 1 saved 3 operators

   B Project 2 saved 7 operators

   C Project 3 saved 4 operators

   D Project 4 saved 0 operators

   E Project 5 reduced maintenance requirements by 40%

3. Labour figures:

   PERIOD 1 - 40 operators PERIOD 2 - 30 operators.

4. Imposed cost actions.

   A. Material cost increases

      (i) 9% on raw material costs.

      (ii) 20% on maintenance materials costs.

   B. Wages increased by 50%

   C. Maintenance wages increased by 50%.

5. No cost reductions of non defined origins.

6. Fixed costs increased due to increased staff salaries.

Now we have the information required to account for the changes in the various sections of variable costs. We must now examine the variable costs individually, and see which actions had an effect on them.

2.3.2 TOTAL COSTS: (continued)

Material Costs.

From fig.5. we see that we have an increase of £2,000 in materials costs to account for. The increase has been caused by:

1. A volume increase of 10%. Assuming that each product contains approximately the same quantity of materials, then a 10% increase in volume would result in a £1,000 rise in materials costs.

2. We also have a 9% increase in raw materials costs, and 9% of £10,000 = £900.

The two factors account for £1,900 out of a £2,000 increase in materials costs. However, once again we have an "interaction affect" between price and volume (see Appendix B) and this accounts for a further £90.

Thus we can say that the increase in materials costs was caused by:

1.	Volume change	+ £1,000
2.	Price increases	+ £ 900
3.	Interaction effect	+ £ 90
		£1,990

The £10 difference between the actual and calculated change in materials costs is in fact due to a rounding error, caused by the selection of figures for this example. However, there are other reasons that might give rise to a similar discrepancy.

e.g., (1) The estimate of a 9% rise in prices may have been based on an average figure for a number of prices making the total materials costs.

(2) There may have been some management actions, which affected materials costs and are unknown to us.

2.3.2. TOTAL COSTS: (continued)

Material Costs

N.B. It is worth noting that in this case the materials cost is only 10% of the total costs. If however, it had been the most important cost, it might have been necessary to analyse the effect of a change in product mix, especially if all products did not contain the same quantities of materials.

Labour Costs

The labour costs have increased by £5,000, whilst the number of operators has fallen by 10 from 40 to 30. Now from the list of actions affecting the department we see that the following have affected labour costs:

1. A 10% increase in volume we assume would indicate the need for a 10% increase in labour.

2. However, we have 3 cost reduction projects, which resulted in labour reductions:

   A. Project 1 saved 3 operators.

   B. Project 2 saved 7 operators.

   C. Project 3 saved 4 operators.

   i.e., A total saving of 14 operators.

For the purpose of analysis it is important to know whether the savings were made before or after the volume increase. Let us suppose that in this case it was after.

3. We also have wage rises due to negotiations and incentive schemes, resulting in an average increase in labour costs of 50%.

2.3.2. TOTAL COSTS: (continued)

Labour Costs

The order in which we account for the effects is dependent on the order in which the labour changes occurred, i.e., in this case the volume effect before savings.

Therefore, we can say the actions have the following effect:

1. The volume increase of 10% resulting in an increase of 10% of £40,000 = £4,000 or 4 operators.

2. The labour reduction projects reduced the operating strength by 14 operators i.e., a saving of £14,000.

3. Finally, wages rose by 50% i.e., 50% of (£40,000 + £4,000) - £14,000 = 50% of £30,000 = £15,000

Thus we can account for the change in labour costs as follows:

1.	Volume changes increased costs by	+ £ 4,000
2.	Labour projects reduced costs by	- £14,000
3.	Wage negotiations increased cost by	+ £15,000
	giving a net increase of labour costs of	+ £ 5,000

There are a number of points that should be noted about the above evaluation of changes:

1. The absence of an interaction effect.

2. The fact that if the wages calculation had been performed as either the first or second calculation, then all the effects would have been larger, but the net effect the same.

2.3.2. TOTAL COSTS: (continued)

Labour Costs

3. In certain cases it may be necessary to consider the effects of change in product mix.

However all these points are dealt with in Appendix B.

Whilst we are looking at the reasons for changes in labour costs, there are other ratios, easily produced, which may indicate how effective management of labour has been:

For example:

1. Average wages of operators.

2.1. Value added per operator = $\frac{\text{Sales Rev. - Material Costs}}{\text{No. of operators}}$

2.2. Value added per operator after the effects of price increases and product mix changes have been accounted for.

3. Average labour cost per unit - the usefulness of this figure will depend on two factors:

A. Labour content of different products

B. Change in product mix.

For the accounts we are examining the ratios are as follows:

Av.Wages per op.	£1,000 per period	£1,500 per period
Value added per op.	£2,375	2.1.£4,333 2.2.£3,850 (less price + mix changes)
Av.Labour Cost per unit	£ 40	£ 40.9

So we can see from the ratio that the average wages have risen by 50%. However, the average cost per unit has remained almost constant, and the value added per operator, after price increases and mix changes, has risen by approximately 63%. This indicates that whilst wages have risen by an apparently substantial amount, improved management of labour has more than compensated for the increases.

23.2. TOTAL COSTS: (continued)

Labour Costs

Depending on major cost areas of your own department you may generate other ratios, which would be useful in evaluating performance.

Finally, it is often of interest to management to know to what extent inflation affected the rise in wages. e.g. if inflation over the period had been approximately 20% then management would have expected " a cost of living" rise of the order of 20% to be negotiated, before any other demands for increases. So we might wish to show our changes in labour costs as follows:

1. Volume changes increased costs by	+ £ 4,000
2. Labour project reduced costs by	- £14,000
3. Inflation increased costs by	+ £ 6,000
4. Further wages negotiations increased costs by	+ £ 9,000
giving a net increase in costs by	+ £ 5,000

This presentation does also show management savings in a more favourable light, since we can now compare savings of £14,000 against increased costs of £9,000.

N.B. This inflation effect can also be examined for for price increases. In this case management may reasonably assume that prices will increase at the same rate as inflation, and then the real effect of negotiations is the rise in prices above the rate of inflation.

Maintenance Costs

The maintenance costs have fallen by £1,040. In this case maintenance costs in period 1 are made up of:

£3,000 - materials

£2,000 - labour

(We assume that maintenance costs do not vary with volume.)

2.3.2. TOTAL COSTS: (continued)

Maintenance Costs

Now maintenance materials prices have risen by 20%, and labour costs by 50%.

i.e., a total increase of £600 + £1,000 = £1,600 to £6,600.

However, due to management actions maintenance costs have been reduced to £3,960 not increased to £6,600, so management's saving is £2,640.

This assessment could have been arrived at a different way, it if were known that the reductions in labour and materials were both 40%

e.g., a 40% reduction in maintenance costs by management actions would have saved:

+(1) £1,200 - in material costs
(2) £ 800 - in labour costs
= £2,000

However, because of the materials and labour increases we have instead savings of

+£1,200 x 1.20	=	£1,440
£ 800 x 1.50	=	£1,200
		£2,640

This checks with accounting figures because without savings we would have had costs of

£3,000 x 1.2	=	£3,600
+£2,000 x 1.5	=	£3,000
		£6,600

which less savings gives a net figure of £3,960

2.3.2. TOTAL COSTS: (continued)

Power

Power costs and "other" costs are almost insignificant in comparison with total costs, and have not changed, so we can ignore them.

Fixed Costs.

These costs have risen by £4,000. This might have been caused by an increase in staff salaries. However, in many cases fixed costs are allocated to departments by the accountants, and are in many instances beyond the control of management. It is perhaps worth noting that because the costs are "fixed", the accountant is often able to predict them with a reasonable degree of accuracy, and in this case the increase of £4,000 may well have been budgeted for.

.2.4. SUMMARY OF THE TOTAL FINANCIAL EFFECTS OF ACTIONS:

Change in profit = + £27,040

Financial effects of changes:

Sales Revenue:		
Price increases	+ £18,000	
Volume increases	+ £10,500	
Product mix change	+ £ 9,500	
Interaction effect	- £ 1,000	
	+ £37,000	+ £37,000
Material Costs		
Volume increases	+ £ 1,000	
Price increases	+ £ 900	
Interaction effect	+ £ 90	
Rounding error	+ £ 10	
	+ £ 2,000	- £ 2,000
Labour Costs		
Volume increases	+ £ 4,000	
Cost reduction actions	- £14,000	
Wage increases	+ £15,000	
	+ £ 5,000	- £ 5,000
Maintenance Costs		
Cost reduction actions	- £ 2,640	
Price and material rises	+ £ 1,600	
	- £ 1,040	+ £ 1,040
Power and Other Costs	0	0
Fixed Costs	+ £ 4,000	- £ 4,000
		+ £27,040

2.4.(Continued)

Thus we have a change in profit of + £27,040 from the calculated values of various effects, compared with an actual change of + £27,040.

N.B. In the above table increases in costs as compared with increases in revenue have an adverse effect on profit. So when the net effect of actions on different costs are totalled to obtain the final change in profit their sign changes i.e. increases become negative, and vice versa.

Appendix A

THE INTERACTION EFFECT (dP. dV)

In the analysis of change in sales revenue we found that the net effect of the three reasons for change that we considered, were not equal to the actual change. At the time the reason for the difference was attributed to an "interaction effect" between price and volume changes of individual products. This is shown to be the case if we produce some simple mathematical expressions for change in revenue, for each of the three effects we considered.

Let P_A = The price of a unit of product A in period 1.

V_A = The number of units of product A sold in period 1.

$P_A + dP_A$ = The price of a unit of product A in period 2.

where dP_A = The change in price of a unit of product A.

and $V_A + dV_A$ = The number of units of product A sold in period 2.

similarly dV_A = The change in the number of units of product A sold.

Then, if we apply a similar notation to the price and volume of products B, C, D and E for periods 1 and 2, we can express the revenue for each period as follows:

Total Sales Revenue for period 1

$= P_A V_A + P_B V_B + P_C V_C + P_D V_D + P_E V_E$

We can call this expression $= \sum P . V$

Where $\sum$ is a summation sign giving rise to the first expression.

Similarly the Total Sales Revenue for Period 2

$$= (P_A + dP_A)(V_A + dV_A) + (P_B + dP_B)(V_B + dV_B) +$$
$$(P_C + dP_C)(V_C + dV_C) + (P_D + dP_D)(V_D + dV_D) +$$
$$(P_E + dP_E)(V_E + dV_E)$$
$$= \sum (P + dP).(V + dV)$$

Then the change in Sales Revenue between period 1 and 2

$$= \sum (P + dP).(V + dV) \quad - \quad \sum P.V.$$
$$= \sum P.V. + \sum P.dV + \sum VdP + \sum dP.\,dV. \quad - \sum P.V.$$
$$= \underline{\underline{\sum V.dP + \sum P.dV. + \sum dP.\,dV.}} \qquad - \text{A}$$

Now turning to the calculations which we performed

1. The effect of price change we said was

   equal to the Revenue from Period 1 Volumes @ Period 2.

   Prices - Revenue from Period 1 Volumes @ Period 1 Prices

which expressed in the terms we have used above is

$$= \sum V.(P + dP) - \sum P.V. = \sum P.V. + \sum V.dP - \sum P.V.$$
$$= \sum V.dP$$

This is the first term in expression A.

2. The effect of volume change we said was equal to the percentage change in volume x Period 1 volume @ Period 1 prices (i.e. Period 1 Revenue).

$$= \frac{\sum dV.}{\sum V} \times \sum P.V.$$

3. The effect of the product mix change we said was equal to the Revenue from Period 2 Volumes @ Period 1 prices minus Period 1 Revenue adjusted proportionally to the overall volume change.

$$= \sum P.(V + dV) - \sum P.V. \times \sum \left(\frac{V + dV}{\sum V}\right)$$

Product.	Vol. in Pd.1.	Vol. in Pd.2.	dV	Price in Pd.1.(£)	Price in Pd.2.(£)	dP(£)	dP.dV(£)
A	100	100	0	250	250	0	0
B	200	300	+100	100	110	+10	+1000
C	100	150	+50	200	200	0	0
D	400	300	-100	50	80	+30	-3000
E	200	250	+50	100	120	+20	+1000
TOTAL	1000	1100	+100				-1000
	= V	= V+dV	= dV				= dP.dV

fig.6.

Product	VxdP (£)	PxdV (£)	PxV (£)
A	0	0	25,000
B	+ 2000	+ 10000	20,000
C	0	+ 10000	20,000
D	+ 12000	- 5000	20,000
E	+ 4000	+ 5000	20,000
TOTAL	+ 18000	+ 20000	105,000
	= VdP	= PdV	= P.V.

fig.7.

Now the volume effect + the product mix effect

$$= \frac{\sum dV \times \sum P.V.}{\sum V} + \sum P.(V+dV) - \frac{\sum P.V. \times \sum (V + dV)}{\sum V}$$

$$= \frac{\sum dV.\sum P.V. + \sum V.\sum P.V. + \sum V.\sum P.dV}{\sum V} -$$

$$\frac{\sum P.V. \sum V + \sum P.V. \sum dV}{\sum V}$$

$$= \frac{\sum V. \sum P.dV}{\sum V} = \sum P.dV.$$

= This is the second term in expression A.

Thus we have accounted for the first two terms in expression A, leaving only $\sum dP.\ dV$, which when expanded is equal to:

$$dP_A\ dV_A + dP_B\ dV_B + dP_C\ dV_C + dP_D\ dV_D$$

$$+ dP_E\ dV_E$$

i.e., the effect of the interaction of price and volume changes for individual products.

If we look at fig.6. opposite we can see that in fact $\sum dP.\ dV = -£1,000$, and we must adjust our calculated change in revenue by this amount, which reduces the figure from + £38,000 to the actual figure of + £37,000.

Indeed if we add to fig.6. the table shown in fig.7. we have all the information required for an exact evaluation of all reasons for change in revenue. Also this full table would be useful for future reference when considering the effects of possible changes in future schedules. It could be used to determine those changes, which would have an adverse effect on revenue, and hopefully lead to their being rectified.

Finally, it is useful to know when the interaction effect is unimportant i.e. zero. This condition will automatically occur when either:

1) There are no price changes during the period under consideration i.e.

   $dP = 0 \quad \therefore \quad dP.\,dV = 0$ for every product

or,

2) There are no changes in total volume and product mix i.e. no changes in individual volumes.

   so, $dV = 0$ and $dP.\,dV = 0$ for every product

Otherwise we must have an interaction effect analysis.

N.B. We can use the tables shown in figs. 6 and 7 to calculate the effects of changes for various variable costs provided we know the amount of variable cost for each product. Similarly if we know the profit margin on each product we can calculate directly the effects of change in price, volume, and mix on profit.

Appendix B

THE IMPORTANCE OF THE INTERACTION EFFECT IN MATERIALS AND LABOUR COST ANALYSIS.

1. Materials Costs.

In this case we can apply the expression derived for change in revenue, to the change in materials costs.

i.e. Change in costs = P.dV + V.dP + d.P.d.V.

In this case since we are ignoring the effect of product mix change, the volume change effect is simply P.d V. The price change effect bing V.d P.

If materials costs for period 1 where composed of:

1,000 tons of material @ £10 per ton.

then P = £10 dP = + 9% of £10 = + £0.9

V = 1,000 dV = + 100 tons.

So change in costs

= £1,000 + £900 + £90 = + £1,990

i.e., as stated d.P.d.V = + £90

(In fact we are still £10 short of the actual change in costs, however, since this represents an error ½% we can ignore it).

2. Labour Costs

You may remember in the analysis of labour costs we apparently had no interaction effect in our calculations. This was in fact because for each of the labour changes there was no wages change, and so in each case dP = 0 ∴ dP.d V. = 0 (dV = change in the number of operators). Then when wages changed dV = 0 so once again dP dV = 0.

In fact the occurrence of the interaction effect does concern us, if as was mentioned, we considered that wages changes could have accompanied one of the volume changes.

2 Labour Costs: (continued)

We know that labour costs are dependent on two factors:

(i) Wages per operator - P.

(ii) Number of operators - V.

Now in our example dV was first dependent on change in volume of units produced and then on management actions.

So we might express the change in labour costs in the following way:

(1) P1 dV 1 + V1.dP1 + dP1.dV1

+

(2) P2 . dV2 + V2.dP2 + dP2.dV2

where dV1 = change in no. of ops. due to volume changes

dV2 = change in no. of ops. due to management actions.

P1 = wages per op. at the beginning of period 1.

P2 = wages per op. at the beginning of period 2.

Then depending on whether the wages increase occurred during period (1) or (2) we have the following:

A. V1 = 40 ops. P1 = £1,000

dV1 = + 4 ops. dP1 = 0 - No wages rise

Then the change in costs = £1,000 x 4 + 40 x 0 + 4 x 0

= + £4,000 (= P1.dV1)

So for period 2 we have:

V2 = 44 P2 = £1,000

dV2 = - 4 dP2 = + £500

giving a change in costs of P2 dV2 + V2 dP2 + dP2.dV2

= + £1,000 x (- 14) + £00 x 44 + £500 (- 14)

= - £14,000 + £22,000 - £7,000

= + £1,000

2. Labour Costs: (continued)

So we would express the change as follows:

1. Due to Increased Volume	+ £ 4,000
2. Due to Managemnt Action	- £14,000
3. Due to Wages Increases	+ £22,000
4. Due to Interaction Effect	- £ 7,000
giving a net effect of	+ £ 5,000 (equal to the actual change).

In the above evaluation management savings are only £14,000; however it would be reasonable to argue that in fact the interaction effect was also caused by management actions and so the effect could be absorbed to increase savings to £21,000.

Alternatively B.

$V1 = 40 \qquad P1 = £1,000$ - Period 1

$dV1 = +4 \qquad dP1 = +£500$

Then change in costs in period 1 = £1,000 x 4 + £500 x 40 + £500 x 4
= +£4,000 + £20,000 + £2,000
= + £26,000

and $V2 = 44 \qquad P2 = £1,500$

$dV2 = 14 \qquad dP2 = 0$ - No wages rise.

Then change in costs in period 2. = - 14 x £1,500 + 0 x 44 + 0 x - 14

= - £21,000 = Effect of Management Actions.

2. Labour Costs.

Again the net effect of the changes = + £5,000 only in this case the interaction effect is between wages and increase in operator strength due to volume change.

So we can see, by comparing these figures with those produced in the original analysis, that whilst each method produces the same correct end result, the values assigned to the individual reasons for change may vary significantly.

Finally, if we were to examine the effect of a change in product mix on labour costs, we would have to determine the cost of labour of each product, and then perform the same type of analysis as was used when we examined the effect on sales revenue, using labour cost instead of price in the calculation.

APPENDIX I.

DETAILS OF WORK PRODUCED BY COMPANY EMPLOYEES ATTEMPTING TO PERFORM PROFIT IMPROVEMENT WORK.

LOCKHEED

LABOUR MODEL.

1.0.0. COST BREAKDOWN:

Over a period of 9 weeks the charges to the various departmental cost codes were examined and an average cost attributed.
The operatives working in the Lockheed Department were allocated to the various sections.
From the information above it was possible to allocate costs to the various sections.

1.1.0. Rubber Preparation — Cost Code 3120/D

Charges allocated were based on the average of the latter 2 weeks of the 9 week period, due to shift changes i.e., 3 shifts to 2 shifts.

£218 x 52 = £11,336 p.a.,

1.2.0. Moulding

1.2.1. Compression — Cost Code 3122/D & I

17 Male Directs and 3 Male Indirects

£826 x 52 = £42,952 p.a.,

1.2.2. Hydramolds — Cost Code 3123/A & I

5 Male Directs	£207 x 52	=	£10,764
3 Male Indirects	£796 x 3/13 x 52	=	£ 9,568

TOTAL = £20,332 p.a.,

1.2.3. Edgwicks — Cost Code 3123/B

27 Male Directs	£1,315 x 52	=	£68,380
10 Male Indirects	£796 x 10/13 x 52	=	£31,824

TOTAL = £100,204 p.a.,

1.3.0. Finishing

1.3.1. Machine Trim — Cost Code 3124/D & I

1 Male Direct	£52 x 52	=	£ 2,704
7 Females Direct	£214 x 52	=	£11,128

TOTAL = £13,832 p.a.,

1.0.0. COST BREAKDOWN

1.3.0. Finishing: (continued)

1.3.2. Auto Lathes — Cost Code 3125/A

2 Male Directs £118 x 52 = £6,136 p.a.,

1.3.3. Hand Lathes — Cost Code 3125/B

1 Male Indirect £ 54 x 52 = £ 2,808

2 Females "
7 Females Direct } £277 x 52 = £14,196

TOTAL = £17,004 p.a.,

1.3.4. Double Cut Lathes — Cost Code 3125/D

2 Male Indirect £103 x 52 = £5,356

1 Female "
6 Females Direct } £143 x 52 = £7,436

TOTAL = £12,792 p.a.,

1.3.5. Wheelabrate, Rectification, Clean — Cost Code 3126/D & I

1 Male Direct £58 x 52 = £3,016

1 Female Indirect £246 x 1/9 x 52 = £1,421

TOTAL = £4,437 p.a.,

1.3.6. Miscellaneous Finishing — Cost Code 3125/C

1 Male Direct £49 x 52 = £2,548

5 Females Indirect £82 x 52 = £4,264

TOTAL = £6,812 p.a.,

1.0.0. COST BREAKDOWN

1.4.0. Inspection — Cost Code 3127/D & I

47 Female Directs £1245 x 52 = £64,740

6 Females Indirect £184 x 52 = £ 9,568

TOTAL = £74,308 p.a.,

1.5.0. Vendor Checkers — Cost Code 3224/D

1 Male Direct £238 x 1/5 x 52 = £2,475

8 Females Direct £216 x 52 = £11,232

TOTAL = £13,707 p.a.,

1.6.0. Despatch — Cost Code 3128/3

2 Females £219 x 2/7 x 52 = £3,255 p.a.,

1.7.0. Outwork

1.7.1. Internal — Cost Code 3128/3

5 Females £219 x 5/7 x 52 = £8,138 p.a.,

1.7.2. External — Cost Code 3120

Cost of finishing parts outside the factory = £208 x 52 = £10,816 p.a.,

1.7.3. Institutions

Invoiced 1973 = £ 6,049 p.a.,

1.8.0. Sorting — Cost Code 3126

5 Females £246 x 5/9 x 52 = £7,106 p.a.,

1.9.0. Count, Sort and Check — Cost Code 3128

3 Males £837 x 3/20 x 52 = £6,873

1 Female £156 x 1/5 x 52 = £1,612

TOTAL = £8,485 p.a.,

1.0.0. COST BREAKDOWN

1.10.0. Wash — Cost Code 3126

3 Females £246 x 3/9 x 52 = £4,263 p.a.,

1.11.0. Additional Finishing — Cost Code 3128

3 Females £156 x 3/5 x 52 = £4,836 p.a.,

1.12.0. Departmental Services

1.12.1. Standards Room — Cost Code 3224/D

4 Male Directs £238 x 4/5 x 52 = £9,901 p.a.,

1.12.2. Mould Stores — Cost Code 3128

3 Males £837 x 3/20 x 52 = £6,873 p.a.,

1.12.3. Cleaners etc., — Cost Code 3128

14 Males Indirect £837 x 14/20 x 52 = £32,074

1 Female " £156 x 1/5 x 52 = £ 1,612

TOTAL = £33,686 p.a.,

2.0.0. COST ALLOCATIONS:

2.1.0. Barwell Section

See Appendix 1 for time allocated to Compression, Hydramold and Edgwicks.

2.1.1. Compression

£11,336 x 40/156 = £2,902 p.a.,

2.1.2. Hydramolds

£11,336 x 30/156 = £2,182 p.a.,

2.1.3. Edgwicks

£11,336 x 86/156 = £6,252 p.a.,

2.2.0. Moulding Section

2.2.1. Compression

£42,952 p.a.,

2.2.2. Hydramolds

£20,332 p.a.,

2.2.3. Edgwicks

£100,204 p.a.,

2.3.0. Finishing Section

2.3.1. Compression

1/8th of total Outwork Charges = £ 3,125 p.a.,
+
Total remaining finishing = £24,286 p.a.,

TOTAL = £27,411 p.a.,

2.3.2. Hydramolds

3/8ths of total Outwork Charges = £9,376 p.a.,

2.0.0. COST ALLOCATION

2.3.0. Finishing Section: (continued)

2.3.3. Edgwicks

1/2 of total Cutwork Charges	£12,502
+ Remaining finishing charges	£57,382

TOTAL = £69,884 p.a.,

2.4.0. Inspection Section

Costs allocated on a volume of parts basis.

2.4.1. Compression

£74,308 x 16.4/100 = £12,186 p.a.,

2.4.2. Hydramolds

£74,308 x 11.4/100 = £ 8,471 p.a.,

2.4.3. Edgwicks

£74,308 x 72.2/100 = £53,650 p.a.,

2.5.0. Vendor Checks

2.5.1. Compression

£13,707 x 16.4/100 = £2,248 p.a.,

2.5.2. Hydramolds

£13,707 x 11.4/100 = £1,563 p.a.,

2.5.3. Edgwicks

£13,707 x 72.2/100 = £9,896 p.a.,

3.0.0. LABOUR COST OF REJECTS.

3.1.0. Compression

Moulding Rejects = 28.62%

Finishing Rejects = 5.4%

The above figures are based on total production rather than on good parts.

3.1.1. Barwell

Moulding Cost = £831

Finishing Cost = £157

TOTAL COST = £988 p.a.,

3.1.2. Moulding Section

Moulding Cost = £12,293

Finishing Cost = £ 2,319

TOTAL COST = £14,612 p.a.,

3.1.3. Finishing Section

Moulding Cost = £7,845

Finishing Cost = £1,480

TOTAL COST = £9,325 p.a.,

3.1.4. Inspection

Moulding Cost = £3,488

Finishing Cost = £ 658

TOTAL COST = £4,146 p.a.,

3.1.5.

Total Moulding Cost = £24,457 p.a.,

Total Finishing Cost = £ 4,614 p.a.,

TOTAL COST = £29,071 p.a.,

3.0.0. LABOUR COST OF REJECTS: (continued)

3.2.0. Hydramolds

Moulding Rejects	=	25.0%
Finishing Rejects	=	3.3%

3.2.1. Barwell

Moulding Cost	=	£545
Finishing Cost	=	£ 72
TOTAL COST	=	£617 p.a.,

3.2.2. Moulding Section

Moulding Cost	=	£5,083
Finishing Cost	=	£ 670
TOTAL COST	=	£5,753 p.a.,

3.2.3. Finishing Section

Moulding Cost	=	£2,344
Finishing Cost	=	£ 309
TOTAL COST	=	£2,653 p.a.,

3.2.4. Inspection

Moulding Cost	=	£2,118
Finishing Cost	=	£ 280
TOTAL COST	=	£2,398 p.a.,

3.2.5.

Total Moulding Cost	=	£10,090
Total Finishing Cost	=	£ 1,331
TOTAL COST	=	£11,421 p.a.,

3.0.0. LABOUR COST OF REJECTS: (continued)

3.3.0. Edgwicks

Moulding Rejects	=	12.05%
Finishing Rejects	=	4.72%

3.3.1. Barwell

Moulding Cost	=	£ 753
Finishing Cost	=	£ 295
TOTAL COST	=	£1,048 p.a.,

3.3.2. Moulding Section

Moulding Cost	=	£12,075
Finishing Cost	=	£ 4,730
TOTAL COST	=	£16,805 p.a.,

3.3.3. Finishing Section

Moulding Cost	=	£ 8,421
Finishing Cost	=	£ 3,298
TOTAL COST	=	£11,719 p.a.,

3.3.4. Inspection

Moulding Cost	=	£6,465
Finishing Cost	=	£2,532
TOTAL COST	=	£8,997 p.a.,

3.3.5.

Total Moulding Cost	=	£27,714
Total Finishing Cost	=	£10,855
TOTAL COST	=	£38,569 p.a.,

3.0.0. LABOUR COST OF REJECTS: (continued)

3.4.0. Total Labour Costs of Rejects for all Sections:

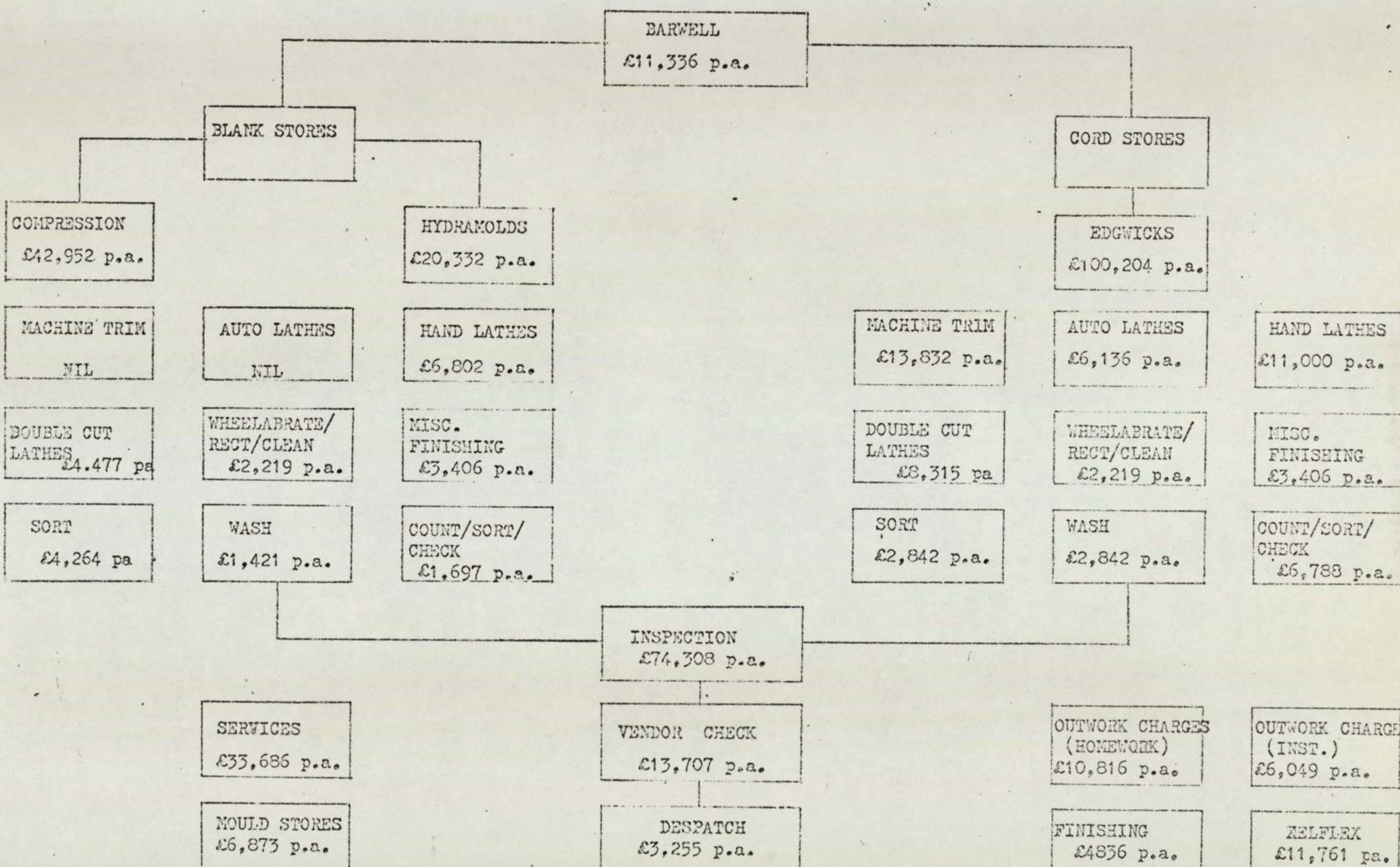
Moulding Costs	£62,261 p.a.,
Finishing Costs	£16,800 p.a.,
Total Cost of Labour used to produce Rejects	= £79,061 p.a.,

7th February 1974.

G. H. Hunter,
Process Engineer -
North Factory.

IG

LABOUR COST MODEL - LOCKHEED DEPARTMENT



MATERIALS MODEL

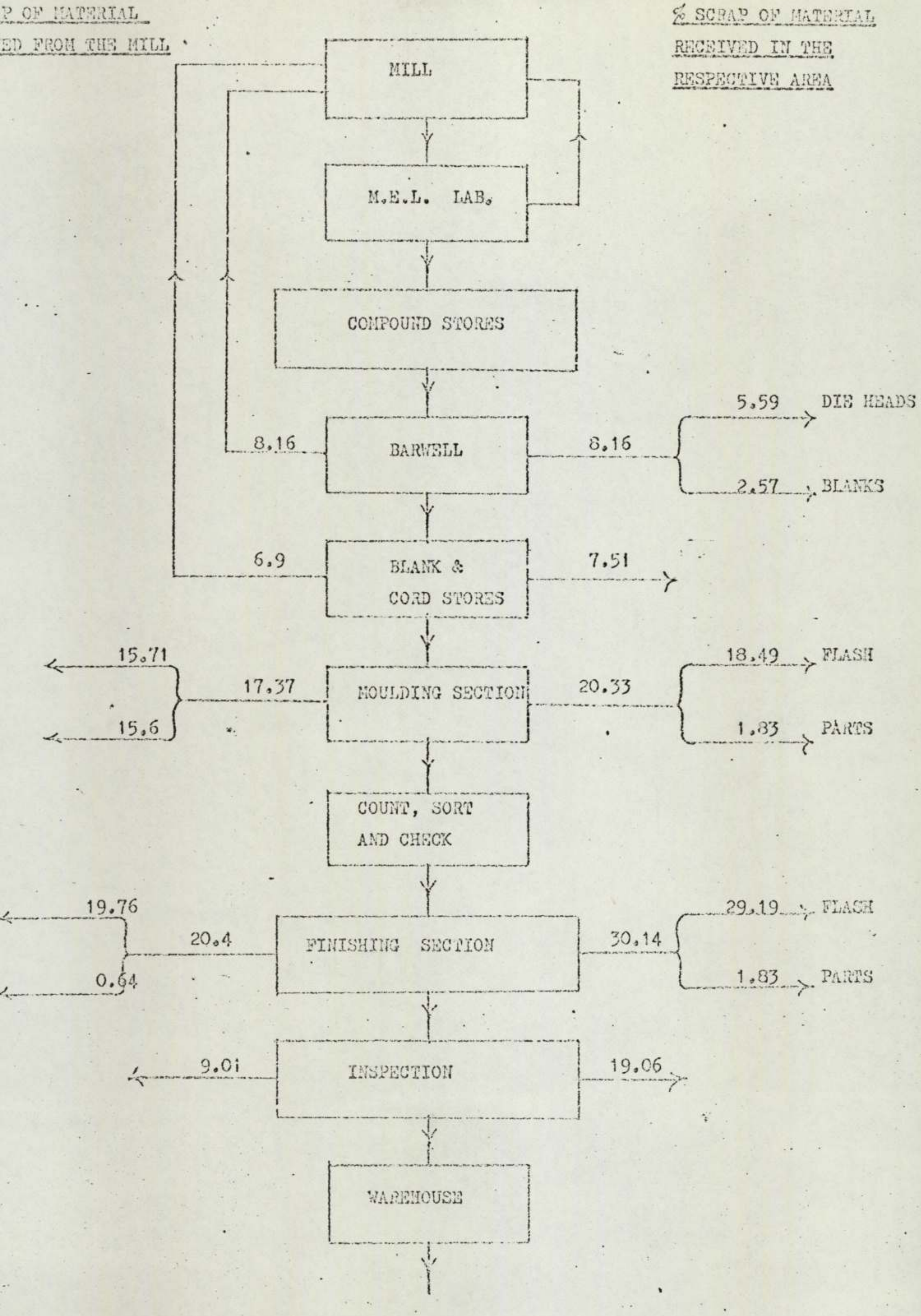
igures recorded are those received over a ten week period. By calculation the early consumption was determined.

	Weight Kg/10wk.	Weight Kg/1 wk.	Weight Kg/48wk.	% Disposed.	Value £ p.a.
Material received	107,210	10,721	514,608	-	120,933
Total material disposed	66,175	6,618	317,564	61.73	74,651
Flash returned at presses	16,838	1,684	80,832	15.71	18,996
Flash returned at finishing	21,184	2,118	101,664	19.76	23,891
Parts scrapped at presses	1,669	167	8,016	1.56	1,884
Parts scrapped at finishing	685	69	3,312	0.64	778
Parts scrapped at inspection	9,658	966	46,368	9.01	10,896
Barwell die head	5,993	599	28,752	5.59	6,757
Barwell blanks	2,749	275	13,200	2.57	3,102
Material from blank stores	7,399	740	35,520	6.90	8,347

Value of material is based on figures received from the Accounts Department of £0.2350/kg.

Total value of material disposed = £74,651 p.a.

Approximate value of parts scrapped as material = £13,558 p.a.


% SCRAP OF MATERIAL
RECEIVED FROM THE MILL
% SCRAP OF MATERIAL
RECEIVED IN THE
RESPECTIVE AREA
MILL
M.E.L. LAB.
COMPOUND STORES
BARWELL
8.16
8.16
5.59
DIE HEADS
2.57
BLANKS
BLANK &
CORD STORES
6.9
7.51
MOULDING SECTION
15.71
17.37
15.6
20.33
18.49
FLASH
1.83
PARTS
COUNT, SORT
AND CHECK
FINISHING SECTION
19.76
20.4
0.64
30.14
29.19
FLASH
1.83
PARTS
INSPECTION
9.01
19.06
WAREHOUSE

.3.74.

GIRLING SCRAP COSTS.

1. SCRAP FIGURES (1.1.74. - 31.3.74.)

			% of total.	% of good
Total parts insp.	=	11,433,792		
Total good parts	=	9,789,257	85.6	100
Total scrap parts	=	1,644,535	14.4	16.8
Moulding scrap parts	=	1,300,794	11.4	13.3
Part/off scrap parts	=	343,741	3.0	3.5

2. 11.4% MOULDING SCRAP

Cost of wasted labour (using figures on Model)

1.	Rubber Prep. cost	=	£2,600 p.a.
2.	Moulding Labour cost	=	£8,800 p.a.
3.	Finishing Labour cost	=	£7,200 p.a.
4.	Inspection Labour cost	=	£5,600 p.a.
	Total labour cost of moulding scrap	=	£24,200 p.a.

3. 3.0% FINISHING SCRAP

Cost of wasted labour (using figures from Model)

1.	Rubber Prep. cost	=	£ 700 p.a.
2.	Moulding Labour cost	=	£2,300 p.a.
3.	Finishing Labour cost	=	£1,900 p.a.
4.	Inspection Labour cost	=	£1,500 p.a.
	Total labour cost of finishing scrap	=	£6,400 p.a.

TOTAL LABOUR COST OF SCRAP = £30,600 p.a.

.74.

4. Materials Cost of Scrap

Annual Materials Costs	=	£60,000 p.a.
Materials Cost of Moulding Scrap	=	£ 6,800 p.a.
Materials Cost of Finishing Scrap	=	£ 1,800 p.a.
Total Materials Cost of Scrap	=	£ 8,600 p.a.

5. Cost of Scrap in Terms of Lost Revenue

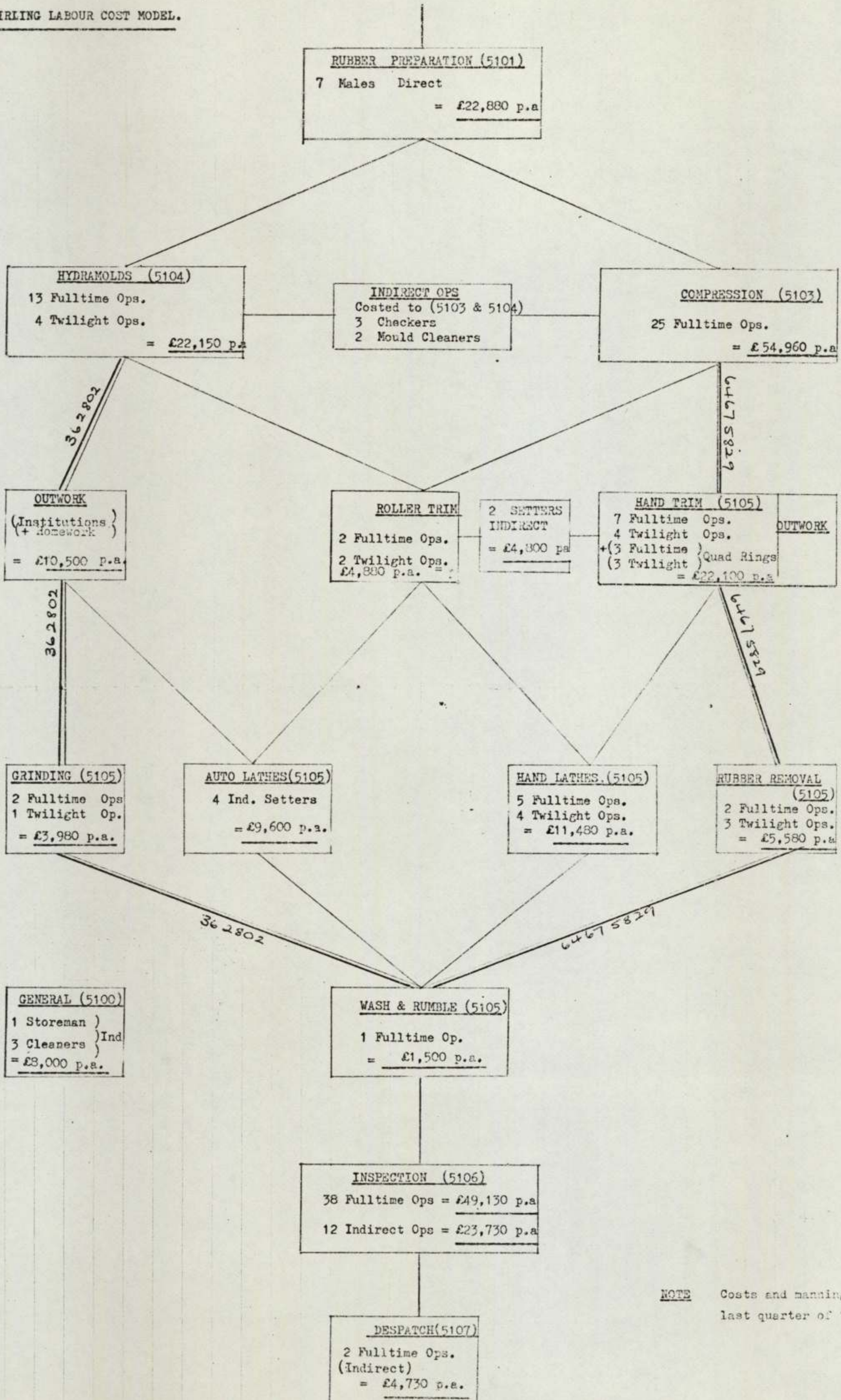
Total scrap parts in first quarter of 1974 = 1,644,794

Av. selling price of parts in first quarter = £0.02 per part

∴ Sales value of scrap = £33,000 approx.

or = £132,000 p.a.

GIRLING LABOUR COST MODEL.



NOTE Costs and manning as of last quarter of 1973.

SUMMARY OF GIRLING LABOUR (FROM MODEL)

STAFF - 17

OPERATIVES - 155 (including 17 Twilight Ops.)

(Dir.Ops. - 88 Insp.Ops. - 33 Final + 12 Other Insps.)
(Other Ind. Ops. - 17)

1.	Ratio of Dir : Ind Ops.	=	88 : 67	=	1.31 : 1
2.	Ratio of Insp : Dir Ops.	=	50 : 88	=	1 : 1.76
3a	Ratio of Staff: Dir Ops.	=	17 : 88	=	1 : 5.17
3b	Ratio of Staff: Ops.	=	17 : 155	=	1 : 9.12
4a	Av. Contrib. per Op.	=	£1,710 p.a.		
4b	Av. Contrib. per Dir Op.	=	£3,050 p.a.		

NOTES ON 362802 & 64675829

1. 362802 — T/O £60,500 p.a. = 4,500,000 parts

Labour Involved:

Hydramolds - 2 Ops.

Hand Trim - O/W - 1 Op.

Grinding - 2½ Ops.

Inspectors - 1 Op.

∴ T/O per Op. = £9,380 p.a.

Contrib. per Op. = £5,157 p.a.

2. 64675829 — T/O £60,400 p.a. = 1,250,000 parts

CONTRIB. £36,600 p.a.

Labour Involved

Comp. Moulders - 2 Ops.

Scissor Trim - 2 Ops.

Rubber Removal - 3½ Ops.

Inspectors - 1 Ops.

∴ T/O per Op. = £7,107 p.a.

Contrib. per Op. = £4,303 p.a.

NOTES:

T/O FROM COMP. PARTS	- £285,000	Based on:	
AV. CONTRIB.	- £ 95,200	Av. S/Price	1.8p/part
T/O FROM FROM HYDRAMOLD PARTS	- £522,000	Av. V.W.C.	1.2p/part
AV. CONTRIB.	- £174,000	Av. Gross Cont.	0.6p/part

REJECT ANALYSIS - PROOFING DEPARTMENT(JULY 1974).

SUMMARY OF DATA:

Total issued	2,611 yds.		
Total received	2,540 yds.		
Total plying up & precure scrap	71 yds	=	2.7% of total
Total inspection scrap	337 yds	=	12.9% of total

BREAKDOWN OF INSPECTION SCRAP(YDS)

			% of total scrap.
Black bits	-	72.3	21.4
Creep	-	68.5*	20.3
Latex	-	20.6	6.1
Creases	-	20.2	6.0
Seeds	-	17.1	5.1
Sweat marks	-	15.5	4.6
Chalk holes	-	13.0	3.9
Black rubber	-	11.2	3.3
Indents	-	11.0	3.3
Bar marks	-	6.7	26.0
Black lines	-	5.7	
Pin holes	-	4.2	
Wood	-	3.0	
Misc.	-	67.8	
TOTAL	-	336.8 yds.	

* The "creep" total contains 61.2 yds from 1 blanket which may distort the above percentages.

COMPARISON OF GENERAL SCRAP RATES:

	END'73.	JLY'74.
Plying up + precure	6.6%	2.7%
Final inspection	10.0%	12.9%
TOTAL	16.6%	15.6%

COMMENTS:

1. There appears to be a slight fall in the total scrap rate, however, the sample of data for the July 1974 analysis was very much smaller than for the '73 analysis, which might cause such a deviation.

2. The "plying-up" and "pre-cure inspection" scrap has dropped by over 50%. but has unfortunately been off set by 30% increase in final inspection scrap.

Circulation:

Mr. D.M. Parr
Mr. M. Crowson
Mr. D. Frearson
Mr. G. Blake
Mr. J. Carr

KG.29.8.74.,

SALES TURNOVER		£ 1,500,000 p.a.
MATERIALS		£ 680,000 p.a.
LABOUR		£ 260,000 p.a.
VARIABLES		£ 84,000 p.a.
MAINTENANCE		£ 20,000 p.a.
POWER		£ 46,000 p.a.
	TOTAL VARIABLE COST	£ 1,090,000 p.a.
	CONSTANTS	£ 360,000 p.a.
	TOTAL COSTS	£ 1,450,000 p.a.
	OPERATING MARGIN	£ 50,000 p.a.

ESTIMATED PROFIT / LOSS ACCOUNT FOR ALL PROOFING PRODUCTS

BASED ON LAST QUATER OF 1973 .

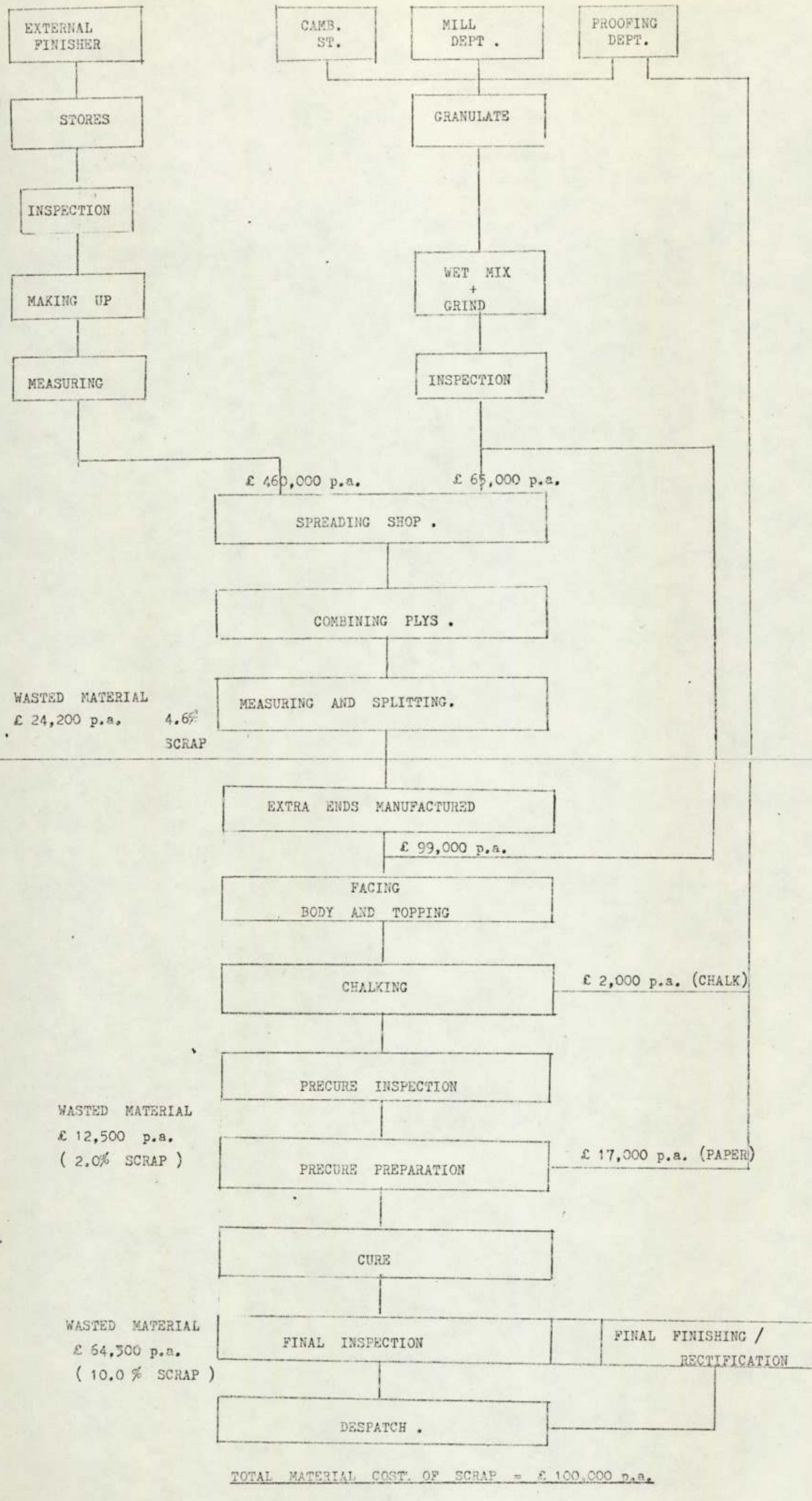
POINTS OF INTEREST :

1. A 10% incrrase in output would double the operating margin .
2. A 10% increase in textile costs if not accompaned by a rise in sales price would virtually eliminate the operating margin . (See breakdown of materials costs .)

MATERIALS COST BREAKDOWN .

(FIGURES ARE ONLY APPROXIMATIONS)

TEXTILES	£ 460,000
PLYING - UP COMPOUND	£ 61,000
BODY AND TOPPING COMPOUND	£ 91,000
TOLUENE	£ 12,000
CHALK	£ 17,000
BLANKET COMPOUND TOTAL	£ 643,000
(NYLON MATERIALS	£ 44,000)



TOTAL MATERIAL COST OF SCRAP = £ 100,000 p.a.

APPENDIX J .

LIST OF REFERENCES .

APPENDIX J (i)

Journals included in

"CONTENTS PAGES IN MANAGEMENT"

MANCHESTER BUSINESS SCHOOL

ABACUS

ACADEMY OF MANAGEMENT JOURNAL

ACCOUNTANCY

ACCOUNTANT

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BANCA NAZIONALE DE LAVORO QUARTERLY REVIEW

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BRITISH JOURNAL FOR THE PHILOSOPHY OF SCIENCE

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